RUSSIAN RIVER
DRAFT BIOLOGICAL ASSESSMENT, PART I

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
San Francisco District
San Francisco, California

and

SONOMA COUNTY WATER AGENCY
Santa Rosa, California

Prepared by:

ENTRIX, INC.
Walnut Creek, California

June 13, 2003

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Term	*Definition*
A	
AF	acre-feet
AFY	acre-feet per year
ADCP	Acoustic Doppler Current Profiles
ARM Plan	Aggregate Resource Management Plan
ASR	aquifer storage and recovery
AWG	Agency Work Group
B	
BA	Biological Assessment
BASMAA	Bay Area Stormwater Management Agencies
BKD	Baterial Kidney Disease
BML	Bodega Marine Laboratory
BMP	best management practice
BO	Biological Opinion
BOD	biological oxygen demand
BRA	Benefit Risk Analysis
C	
CCC	Central California Coast
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDHS	California Department of Health Services
CDWR	California Department of Water Resources
CFR	Code of Federal Regulations
cfs	cubic-feet per second
cfs/hr	cubic feet per second per hour
cm	centimeter(s)
cm/s	centimeters per second

Term	***Definition***
CRP	Circuit Rider Productions, Inc.
CVD	Coyote Valley Dam
CVDP	Coyote Valley Dam Project
CVFF	Coyote Valley Fish Facility
D	
D1610	Decision 1610
DCFH	Don Clausen Fish Hatchery (also known as Warm Springs Fish Hatchery)
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
E	
El.	elevation
EIS	Environmental Impact Statement
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ESA	Federal Endangered Species Act of 1973
Estuary	Russian River Estuary
ESU	Evolutionarily Significant Unit
EWSL	Emergency Water Supply Line
F	
FEIS	Final Environmental Impact Statement
FEP	Fisheries Enhancement Project
FERC	Federal Energy Regulatory Commission
FL	fork length
fps	feet per second
FR	Federal Register
ft/hr	feet per hour
ft^3	cubic feet

Term	***Definition***
G	
gpd	gallons per day
gpm	gallons per minute
GIS	Geographical Information System
H	
HGMP	Hatchery and Genetic Management Plan
hp	horsepower
hr	hour(s)
I	
IPM	Integrated Pest Management
J	
K	
km	kilometer(s)
km/h	kilometer(s) per hour
KRIS	Klamath Resource Information System
KW	kilowatt(s)
L	
Laguna	Laguna de Santa Rosa
lf	linear feet
LMHPP	Lake Mendocino Hydroelectric Power Plant
LWD	large woody debris
M	
m^3/s	cubic meter(s) per second
M&E Plan	Monitoring and Evaluation Plan
MCIWPC	Mendocino County Inland Water and Power Commission
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
mgd	million gallons per day

Term	***Definition***
mg/l	milligram(s) per liter
min	minute(s)
ml	milliliter
mm	millimeter(s)
MMWD	Marin Municipal Water District
MOU	Memorandum of Understanding
MSL	mean sea level
Mt DNA	Mitochondrial DNA
MW	megawatt(s)
N	
NBWA	North Bay Watershed Association
NCPA	Northern California Power Authority
NCWAP	North Coast Watershed Assessment Program
NFP	Natural Flow Proposal
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service, now known as NOAA Fisheries
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric turbidity unit
O	
O&M manual	operation and maintenance manual
P	
PG&E	Pacific Gas and Electric Company
PIT	Passive Integrated Transponder
PMG	Prince Memorial Greenway
PPFC	Public Policy Facilitating Committee
ppm	parts per million
ppt	parts per thousand

Term	*Definition*
PVP	Potter Valley Project
Q	
QPF	Quantitative Precipitation Forecast
R	
Rkm	river kilometer
Rm	river mile
RMA	Resource Management Associates
RRCWD	Russian River County Water District
RREITF	Russian River Estuary Interagency Task Force
RRSM	Russian River System Model
RRWQM	Russian River Water Quality Model
RWQCB	North Coast Regional Water Quality Control Board
S	
SCWA	Sonoma County Water Agency
SL	standard length
SWMP	storm water management program
SWRCB	State Water Resources Control Board
T	
THP	Timber Harvest Plans
TMDL	Total Maximum Daily Load
TOC	Technical Oversight Committee
U	
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V	

Term	***Definition***
W	
WDFW	Washington Department of Fish and Wildlife
WSD	Warm Springs Dam
WSDP	Warm Springs Dam Project
WSE	water surface elevation
WSTSP	Water Supply and Transmission System Project
X	
Y	
YOY	young of the year
Z	

The U.S. Army Corps of Engineers (USACE), the Sonoma County Water Agency (SCWA), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 Consultation under the federal Endangered Species Act (ESA) with NOAA Fisheries (formerly National Marine Fisheries Service [NMFS]) to evaluate effects of their operations and maintenance activities on listed species and their habitats. This consultation addresses the effects of project operations on threatened stocks of coho salmon, steelhead, and Chinook salmon in the Russian River watershed in Sonoma and Mendocino counties. USACE, SCWA, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, water supply and diversion, hydroelectric power generation, water management, estuary management, channel maintenance, habitat restoration, and fish production. In addition, these agencies are participants in a number of institutional agreements related to fulfilling their respective responsibilities.

A series of interim reports were developed to evaluate effects of ongoing and past USACE, SCWA, and MCRRFCD operations. Additional reports were generated to evaluate potential future actions. Alternative operations scenarios were developed to address issues and concerns that arose from evaluation of ongoing operations and evaluation of future needs. Based on the alternatives analyses, modifications to operations and maintenance procedures are proposed.

This document is part of the Biological Assessment (BA). The focus is to provide a preliminary project description that identifies ongoing actions and describes the proposed changes and modification to facilities, operations and maintenance activities (Section 3). To provide context for these operational changes, the institutional agreements and constraints are described in Section 1. Section 2 presents the status of the listed species in the Russian River and the elements of the environmental baseline associated with the ongoing and past project activities.

The Draft BA, published later this year, will include updates for sections 1 through 4 and new sections to present the effects analysis. Section 2, the environmental baseline, will include additional information on non-project factors in the regional setting such as agriculture, urbanization, timber harvest and gravel mining. Section 3 will be updated to include revisions to the project description based on additional analysis or review comments provided to the action agencies (USACE, SCWA, and MCRRFCD).

The new sections 5 through 9 will include the analysis of effects on listed species from proposed project operations and maintenance or modification of facilities. The effects of interrelated/interdependent activities and effects of future non-federal actions (cumulative effects) will be evaluated. A monitoring plan and an implementation plan, Section 10, will be developed as part of the Draft BA. After comments are received on the Draft BA, a Final BA will be prepared and submitted to NOAA Fisheries. NOAA Fisheries will then prepare a Biological Opinion (BO) for the proposed project.

In this document, the proposed project description in Section 3 describes the modifications to the operations and maintenance practices that are being considered for implementation. Some of the modifications are in progress or are being implemented on a trial basis. Some modifications will require more analysis and development before they can be implemented. Some modifications require the construction of new facilities or regulatory approvals before proceeding.

Major, or noteworthy, proposed changes are presented below:

- Make structural and operational modifications at Coyote Valley Dam (CVD).
    - Reduce effects to fish during annual inspection and maintenance operations by providing a minimum instream flow and reducing the ramping rate.
- Make structural and operational changes at Warm Springs Dam (WSD).
    - Repair and cleaning of the uppermost tunnel at the control structure of the dam.
    - Reduce ramping rates.
    - Improve the reliability and quantity of the water supply to the hatchery.
- Make structural and operational modifications at the Mirabel and Wohler diversion facilities to reduce effects to young fish.
    - Improve fish screens at both diversions.
    - Improve fish passage at the inflatable dam.
    - Reduce the opportunity for entrapment in the infiltration ponds.
- Modify releases from WSD and CVD.
    - Lower instream flows during the summer in Russian River and in Dry Creek below those required under State Water Resources Control Board (SWRCB) Decision 1610 (D1610).
    - Reduce the need for artificial breaching of the sandbar at the river mouth during the summer.
    - Develop additional water supply measures to meet future demand while protecting fish habitat.
- Modify channel maintenance activities.

- Focus bank stabilization in the Russian River to specific sites and modify protocols to benefit listed fish species.
- Adaptively manage vegetation and/or sediment maintenance activities in flood control channels and natural waterways to improve habitat, where feasible.

- Revise fish production facility operations to implement:
    - An isolated harvest program for steelhead;
    - An integrated recovery program for coho salmon (beginning with the captive broodstock program);
    - No hatchery production for Chinook salmon; and
    - Future programs that could include an integrated harvest program for steelhead and an integrated recovery program for Chinook salmon, if warranted.

Additional descriptions of changes to facilities and operations are provided below.

FLOOD CONTROL, WATER STORAGE, AND SUPPLY OPERATIONS

Coyote Valley Dam

Under the proposed project, Lake Mendocino would continue to be managed for flood control, water supply, and hydroelectric power generation.

Annual and periodic (5-year) pre-flood inspections would continue to be performed. Modifications would be implemented to reduce the risk of stranding young fish when flow releases from the dam are reduced (ramped down) for these activities. USACE would supply a bypass flow of 25 cubic feet per second (cfs) to the East Fork Russian River during inspection and maintenance activities. A 15-cfs release from the bypass pipeline could supply water to the Coyote Valley Fish Facility (CVFF), if needed. Dam inspections would be scheduled later in the season (between July 15 and October 15) so that salmonid fry, which are more susceptible to stranding than larger juveniles, have time to grow before the inspections occur. Ramping rates at flows less than 250 cfs would be reduced from 50 cfs per hour (cfs/h) to 25 cfs/h to reduce the risk of stranding fish. The outlet structure at the dam would be modified to allow greater control over the gate opening and allow for the reduced ramping rates.

Warm Springs Dam

Lake Sonoma would continue to be operated for flood control, water supply, and hydroelectric power generation. As with CVD, maintenance and inspection activities at WSD would continue. When releases from the dam are less than 250 cfs, they would be ramped down at 25 cfs/h or less and a minimum bypass flow of 25 cfs would continue to be provided to Dry Creek. Modifications would be made to the water supply line to the Don Clausen Fish Hatchery (DCFH) to provide a more reliable hatchery water supply. Proposed modifications to flow releases would reduce the quantity of hydroelectric power generated.

Transmission System

SCWA would continue to divert and deliver water to its customers through the water transmission system. This system consists of diversion facilities, treatment facilities, pipelines, water storage tanks, booster pump stations, and groundwater wells. SCWA would continue to operate and construct the transmission system facilities, as authorized under the Eleventh Amended Agreement for Water Supply (SCWA 2001a), to meet current and future water supply demand.

The inflatable dam at the Mirabel diversion facility would continue to be operated to increase infiltration to the aquifer beneath the river streambed. Ramping rates during inflation of the Mirabel inflatable dam would be modified to reduce the risk of stranding juvenile salmonids downstream of the dam. SCWA plans to create a single depression in the crest of the inflatable dam in the spring and early summer (through July 15). This action concentrates flow of water over the dam to facilitate smolt outmigration. The Mirabel intake structure and fish screens would be reconfigured to comply with NOAA Fisheries and California Department of Fish and Game (CDFG) fish screen criteria to protect young fish at the diversion (on the west side of the dam). If needed, the east-side fish ladder and the east-side bypass pipeline would be modified to improve fish passage.

At the Wohler diversion, new intake structures and new fish screens would be installed to protect young fish when the diversion is in operation. The fish screens would be removed when the inflatable dam is lowered. Fish entrained during winter storms could return to the river. The infiltration ponds would be graded to promote drainage back to the river and reduce the risk of stranding fish. Fish rescues would continue to be conducted, if needed.

WATER MANAGEMENT

Analyses conducted to date indicate that habitat for listed fish species could be improved by decreasing summer flows (ENTRIX, Inc. 2002b). Under the proposed project, releases from WSD and CVD would be modified to: reduce summer water velocities in Dry Creek and the upper Russian River; conserve the cold-water pool in Lake Mendocino through the late summer; provide sufficient water to satisfy existing water rights obligations in the Russian River and Dry Creek; meet future demand on the SCWA system as defined by the Water Supply and Transmission System Project (WSTSP); and allow the sandbar at the mouth of the Russian River to be closed in the summer. To implement the proposed flow regime, D1610 would need to be modified by a new order from SWRCB.

The most substantial changes to flow would occur in summer (June to October). Summer flows downstream of CVD and WSD would be lower than those under current conditions. Under current conditions, median flows in the Russian River near Ukiah are typically about 170 to 230 cfs. Under the proposed project, they would range from approximately 140 to 210 cfs under current demand. Near Cloverdale, the median monthly flows could range from 130 to 200 cfs. Near Healdsburg, they could range from 130 to 160 cfs. Flows in the river downstream of the Mirabel inflatable dam would be managed so that flow to the Russian River Estuary (Estuary) is low enough to avoid the need to artificially breach the sandbar at the river mouth. Near Hacienda, median monthly flows would range from approximately 50 to 90 cfs under current demand.

Below WSD, median monthly flows in Dry Creek could range from approximately 45 to 70 cfs under current demand. Flows at the mouth of Dry Creek would be slightly lower. Flow releases during *dry* water supply conditions are expected to be higher and may reach 200 cfs for short periods. Under *critically dry* water supply, conditions will be higher for more extended time periods.

SCWA would develop additional measures to meet future water supply demands while maintaining suitable rearing habitat for young fish. The primary measures being considered are: an aquifer storage and recovery (ASR) program; a pipeline from WSD to the mouth of Dry Creek, the Wohler diversion facility, or a treatment plant; and/or additional storage facilities.

Reduced flow to the Estuary would reduce the need to artificially breach the sandbar during the summer. This action is expected to improve salmonid summer rearing habitat in the estuary. Artificial breaching may still be required to prevent flooding to private property and roads during storm flow, primarily in the fall.

CHANNEL MAINTENANCE

Channel maintenance activities will continue to be conducted in the Russian River and its tributaries to reduce the potential for flooding and bank erosion. Current activities include sediment maintenance, channel debris clearing, vegetation maintenance, and bank stabilization. Activities in channels in the Central Sonoma Watershed Project (constructed flood control channels and specific natural waterways) and in the Russian River would be modified to the extent possible to reduce effects to listed fish species and their habitat.

USACE and SCWA are currently updating the rainfall-runoff relationships in the Santa Rosa Creek watershed. Based on this review, it appears that the 100-year storm flows in this watershed may be of a greater magnitude than had been estimated historically. SCWA plans to perform additional hydraulic modeling to assess the capacity of flood control channels in the Central Sonoma Watershed Project. Appropriate vegetation maintenance practices (i.e., maintain streambank vegetation predominantly as grasses) would be employed in constructed flood control channels where it is needed to maintain hydraulic capacity. For streams in which sufficient flood capacity can be maintained, some canopy cover would be allowed to develop on the upper banks and young trees (thinned and pruned) would be allowed to colonize the lower banks.

SCWA and MCRRFCD bank stabilization activities would continue to be implemented in the Russian River. However, such activities would be modified to reduce potential negative effects on listed fish species. Gravel bar regrading, overflow channel creation, and vegetation maintenance for flood protection purposes would generally be limited to areas with severe bank erosion or where recent substantial changes in channel morphology would likely lead to severe bank erosion. These activities would also be conducted when levees are weakened, or where a flooding threat to infrastructure or private property exists. Additional vegetation maintenance may also occur where there is encroachment of exotic pest plants such as *Arundo donax* (giant reed). The work would be conducted with protocols designed to minimize effects to listed fish species. Areas where frequent and/or extensive channel maintenance actions are required would be identified and assessed as to whether they may be candidates for bank stabilization projects. Bioengineered structures would be used whenever possible. The USACE would review and revise its channel maintenance requirements with SCWA and MCRRFCD to reflect the implementation of channel maintenance and vegetation clearing activities that are aimed at providing greater protection for listed fish species.

HABITAT RESTORATION

SCWA plans to continue its proactive role in habitat restoration and enhancement projects and stewardship of the watershed. These efforts include support for state and federal recovery plans; watershed management; riparian and aquatic habitat protection, restoration, and enhancement; fish passage improvement projects; and water conservation and recycling. To maximize the effectiveness of dollars invested, SCWA plans to assist in developing project priorities on a basin-wide level, in cooperation with CDFG, other public agencies, and private interests in the watershed. SCWA will also continue its public information and education programs to increase awareness of the importance of protecting and restoring habitat for listed species.

FISH PRODUCTION FACILITY OPERATIONS

The DCFH and CVFF were developed to mitigate for lost habitat upstream of WSD and CVD, respectively. Fish production goals for DCFH were established to compensate for loss of coho salmon and steelhead production in Dry Creek and to enhance harvest opportunities for coho salmon and Chinook salmon in the Russian River. Fish production goals for CVFF were established to compensate for the loss of steelhead production in the East Fork Russian River upstream of CVD.

Since the 1999/2000 season, an interim operations plan ceased hatchery production of coho salmon and Chinook salmon in the basin. Steelhead production remained unchanged from the original goals. In 2001, a pilot program was implemented to analyze the effectiveness of a captive broodstock program for coho salmon. The coho salmon program is authorized through June 2007 to allow time for adequate implementation and analysis of the enhancement response (NMFS 2001a).

Under the proposed project, fish production practices would be modified and additional facilities would be constructed. The mitigation and enhancement goals for coho salmon and Chinook salmon will be put on hold for an interim period. The mitigation obligations of USACE for coho salmon, steelhead, and Chinook salmon will be formally revised to provide objectives that are realistic and feasible under current environmental and regulatory conditions. A monitoring program will be implemented and fish production facility operations would incorporate adaptive management practices.

The proposed action for steelhead is a continuation of an isolated harvest program, maintaining existing production and release goals. Artificially produced steelhead would continue to provide harvest opportunities and a source for program broodstock. An integrated recovery program for steelhead (which would incorporate wild steelhead into hatchery broodstock to maintain genetic diversity and reduce domestication) would be evaluated for potential future implementation after additional genetic and population information becomes available.

The proposed project for coho salmon is a supplementation program to support recovery. It would implement the current pilot captive broodstock program. This program is designed to conserve genetic resources of the coho salmon population, which is at risk of extirpation.

Chinook salmon production is not proposed because current abundance data suggest the naturally spawning population appears to be large enough to not be at immediate genetic risk. If new information indicates it is warranted, a supplementation program would be implemented for Chinook salmon.

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1.1 SECTION 7 CONSULTATION

The U.S. Army Corps of Engineers (USACE), the Sonoma County Water Agency (SCWA), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 Consultation under the federal Endangered Species Act (ESA) with NOAA Fisheries (formerly National Marine Fisheries Service [NMFS]). This Section 7 consultation will evaluate the effects of operations and maintenance activities on listed salmonid species and their habitats in the Russian River watershed in northern California. The action agencies involved include: USACE, the Sonoma County Water Agency (SCWA), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD).

USACE, SCWA, and MCRRFCD activities span the Russian River watershed from Coyote Valley Dam (CVD) and Warm Springs Dam (WSD) to the Russian River Estuary (Estuary), as well as several tributaries. The Russian River watershed supports threatened coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and Chinook salmon (*Oncorhynchus tshawytscha*). USACE, SCWA, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, channel maintenance, water diversion and storage, hydroelectric power generation, and fish production and passage. In addition, these agencies are participants in a number of institutional agreements related to fulfilling their respective responsibilities.

The ESA requires federal agencies such as USACE to consult with secretaries of the U.S. Department of Interior and/or Commerce to insure that their actions are not likely to jeopardize the continued existence of listed species or adversely modify or destroy critical habitat. USACE determined that their activities in the Russian River watershed may affect listed anadromous fish managed by NOAA Fisheries. Accordingly, USACE, SCWA, MCRRFCD, and NOAA Fisheries have entered into a Memorandum of Understanding (MOU) that sets a framework for the consultation on project activities that may directly or indirectly affect coho salmon, steelhead, and Chinook salmon in the Russian River. The MOU acknowledges the involvement of other agencies, including the California Department of Fish and Game (CDFG), the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (RWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission (MCIWPC).

1.2 SCOPE OF THE BIOLOGICAL ASSESSMENT

As part of the Section 7 consultation, USACE, SCWA, and MCRRFCD will submit to NOAA Fisheries a biological assessment (BA) that describes the actions subject to consultation, including the facilities, operations, maintenance, and existing conservation actions undertaken by the action agencies (USACE, SCWA, and MCRRFCD). The BA will describe environmental baseline conditions, including information on hydrology, water quality, habitat conditions, and fish populations.

The focus of the BA will be the assessment of effects on listed species. The assessment considers potential effects from the proposed new facilities. It also considers project operations and maintenance procedures for new and existing facilities and from interrelated and interdependent facilities. Moreover, it considers potential cumulative effects from future nonfederal actions. The ESA prohibits take of any individual members of a species. Therefore, the document will come to a conclusion of “likely to adversely affect” if any individual fish could be harmed by the proposed action, even if the risk of an adverse effect to the overall population is low. Such a conclusion will mean that one or more individual listed fish might be harmed by the proposed action.

The BA will integrate the effects of a number of project operations:

- Flood Control Operations (at CVD and WSD)
- Water Supply Operations and Operation of the Diversion Facilities (in and adjacent to the Russian River near Mirabel)
- Hydroelectric Projects Operations (at CVD and WSD)
- Water Management (in Dry Creek and in East Fork and mainstem Russian River)
- Estuary Management (at the mouth of the Russian River)
- Channel Maintenance (in the mainstem and tributaries)
- Restoration and Conservation Actions (throughout the watershed)
- Fish Facility Operations (Coyote Valley Fish Facility [CVFF] at CVD and Don Clausen Fish Hatchery [DCFH] at WSD)

Once a BA is submitted to NOAA Fisheries, formal consultation under the ESA will be initiated. NOAA Fisheries will then prepare a Biological Opinion (BO) for the proposed project. The BO will contain an assessment of the effects of the project on the listed populations. NOAA Fisheries will evaluate the potential effects of the proposed project relative to baseline conditions to determine whether the activities of the proposed project are likely to jeopardize the continued existence of the populations under consultation. Their conclusion and supporting analysis will be presented in the BO. As a part of the BO, NOAA Fisheries will issue an incidental take statement to the USACE to cover “take” associated with the performance of activities included in the project description.

This report contains sections that will be part of the BA. It presents a preliminary project description for activities undertaken by the USACE, SCWA, and MCRRFCD. It includes the ongoing operations and maintenance activities that are necessary to meet the obligations of the action agencies. It also includes description of the new facilities and modifications to current operations and maintenance procedures that are being considered for implementation. To provide context for the proposed changes to the project description, the institutional constraints and the elements of the environmental baseline associated with the ongoing and past project activities are included in this report.

The Draft BA that will be completed later this year will include a more complete environmental baseline description for other activities that have contributed to baseline habitat conditions in the Russian River, including agriculture, timber harvest wastewater discharges, gravel mining, and urbanization. It will also present the proposed project description with any updates or changes based on comments received. Additional sections for the Draft BA include the effects analysis based on the project description, interrelated or interdependent actions, and future nonfederal activities. A monitoring program and an implementation plan for the new facilities, and operations and maintenance activities will be included. The Draft BA will be presented to the Public Policy Facilitating Committee (PPFC) for agency and public review. After comments are received on the Draft BA, a Final BA will be prepared and submitted to NOAA Fisheries.

In this document, Section 1, the introduction, presents the structure of the consultation as defined by the MOU, the regulatory history of the listings pertaining to the salmon and steelhead in the Russian River, and a summary of the institutional agreements that govern activities addressed in the BA.

Section 2, the environmental baseline, provides a description of the status of the listed species, their geographic distribution, and their habitat requirements. Section 2 also contains a description of the past and present actions including state, federal, local government, and private actions that are contemporaneous with the Section 7 consultation. Since many of the facilities included in this consultation are already in place and being operated, Section 2 contains a description of the facilities and their operations under the environmental baseline. As described above, the environmental baseline will be updated in the Draft BA to include additional information on non-project factors in the regional setting.

Section 3 presents a preliminary description of the proposed project. Where the proposed operations and maintenance actions are the same as those occurring under the baseline conditions, the descriptions in Section 2 are referenced. The descriptions of new facilities and changes in operation and maintenance practices are presented in Section 3. The changes in operations and maintenance and the additional facilities are proposed primarily to avoid injury to, or improve habitat conditions for, listed salmonids. During the development of the proposed modifications, a large number of alternatives were evaluated. Many of these alternatives will be discussed in an appendix to the Draft BA.

Some of the modifications presented in Section 3 are underway or are being conducted on a trial basis. The description of the action indicates if modifications are being currently implemented. Other modifications proposed in Section 3 of this document are more conceptual and will require additional analyses and further refinement prior to implementation. These will be refined prior to completion of the Draft BA.

Section 4 of this document presents the evaluation criteria that will be used as part of the effects assessment, which will appear in the Draft BA. A major focus of the Draft BA is an assessment of the potential effects of the proposed action. To assist in organizing and conducting the effects analysis across a broad range of activities, evaluation criteria were developed. The evaluation criteria were developed during the preparation of the interim reports that evaluated the existing project facilities, operations, and maintenance. The integration of the effects of the various actions on the different life history stages of coho salmon, steelhead and Chinook salmon will form the basis for the population level assessment. The population level analysis is critical to the determination of jeopardy or non-jeopardy that NOAA Fisheries will make in the BO.

1.2.1 Project Area

The project area includes the Russian River from CVD downstream to the Russian River Estuary, Dry Creek from WSD to the mouth, and a number of smaller tributaries of the Russian River in Sonoma County.

To facilitate the analysis of potential effects, the project area has been subdivided into several geographic regions defined within the project area (Figure 1-1 and Table 1-1). The Russian River has been divided into three major segments, the upper, middle, and lower, following the methodology of Winzler and Kelly (Winzler and Kelly 1978), and defined in *Interim Report 3: Flow-Related Habitat* (ENTRIX, Inc. 2002a). The Estuary is a fourth reach of the river.

Project operations related to WSD, CVD, and water diversion facilities directly affect flows in the mainstem of the Russian River and in Dry Creek, a major tributary of the Russian River. Project operations related to channel maintenance, and restoration and conservation actions, may affect tributaries to the Russian River. The watershed upstream of WSD and CVD was not included in the ESA listing and is not part of the project area. Other factors considered in the definition of these regions include dominant vegetation, sun exposure, and their influences on stream temperature. In general, the western side of the Russian River valley is cooler and subject to coastal fog in the summer, and supports coniferous forest. In contrast, the eastern side of the valley is warmer and drier, and is characterized by oak woodland habitat.

The regions of the watershed that have been defined for this analysis are listed in Table 1-1.

1.2.2 Consultation to Date

USACE, SCWA, and NOAA Fisheries entered into an MOU on December 31, 1997 to establish a framework for the ESA Section 7 consultation. The MOU created three committees to assist the USACE and SCWA with the Section 7 consultation. The Executive Committee, composed of managers for USACE, SCWA, NOAA Fisheries, CDFG, and Mendocino County, provides guidance to the overall process. A technical work group, including staff from USACE, SCWA, NOAA Fisheries, CDFG, and

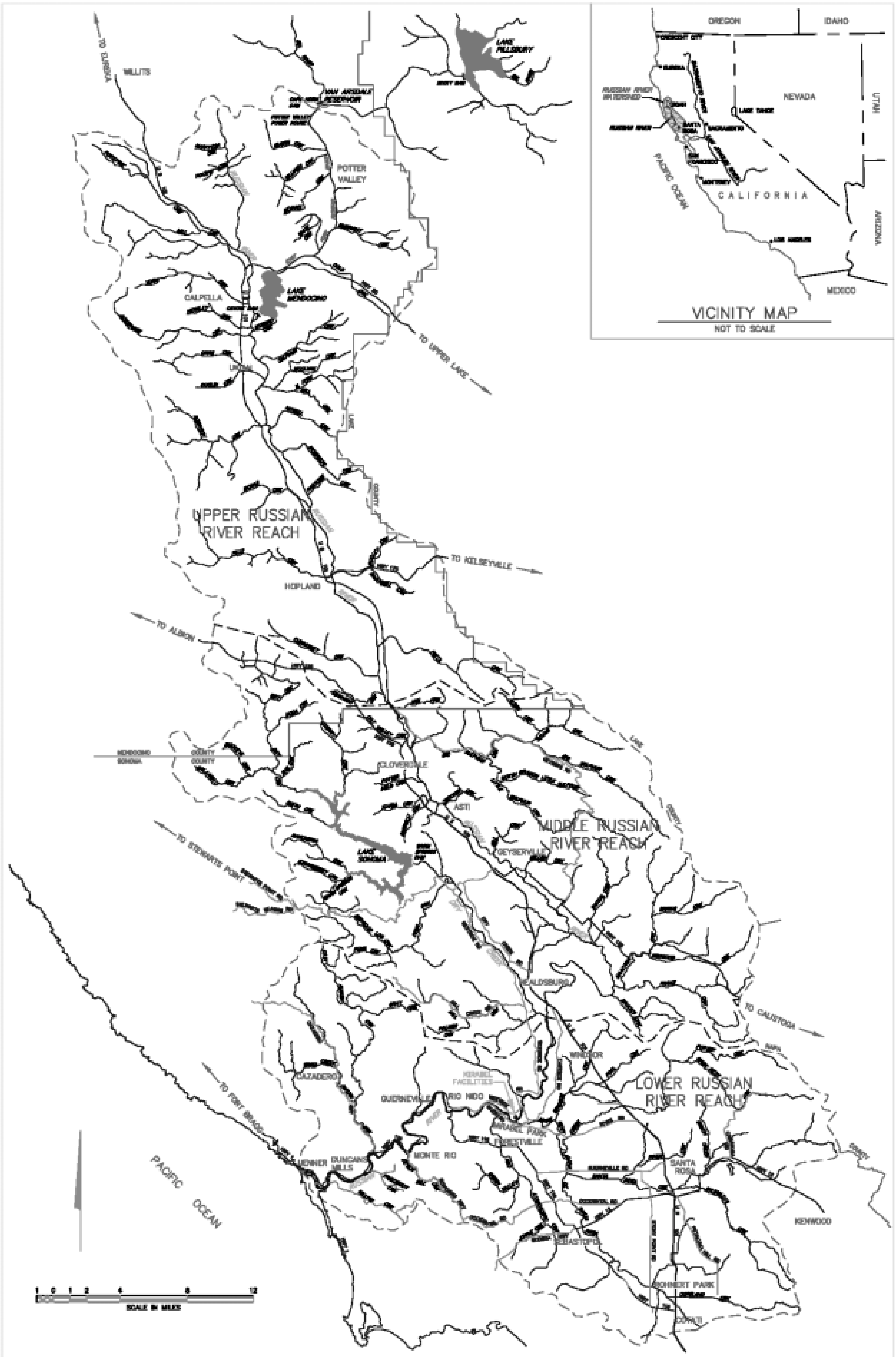

Figure 1-1 Map of the Russian River Watershed and Location of Reach Boundaries

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RWQCB (the Agency Work Group [AWG]), provides technical review of the draft products. The third committee, the Public Policy Facilitation Committee (PPFC), includes county supervisors and managers of state and federal agencies. The role of the PPFC is to provide a conduit to the general public, where reports and analyses can be disseminated and comments and information can be received. The PPFC has discussed the project products and alternative actions for project operations.

A series of interim reports evaluated effects of USACE, SCWA, and MCRRFD operations on coho salmon, steelhead, and Chinook salmon under baseline conditions. Draft interim reports were submitted to the AWG and Executive Committee for review

Table 1-1 Russian River Watershed Regions

Region	Description
East Fork	Includes a short stretch of river downstream of Coyote Valley Dam to the confluence with the Russian River. The confluence of the Russian River and the East Fork is commonly referred to as "the Forks."
Mainstem	Includes the main channel of the Russian River. The mainstem can be divided into four reaches: upper, middle, lower, and Estuary.
Upper Reach	Includes the mainstem of the Russian River between the Forks near Ukiah downstream to Cloverdale. The tributaries on the western side of the valley are influenced by coastal fog during the summer and support coniferous forest. The eastern side of the valley is considerably drier than the western slopes and supports oak woodland with a grassland understory.
Middle Reach	Extends from Cloverdale to the confluence of the mainstem with Dry Creek near Healdsburg. The eastern side of the valley is considerably drier than the western slopes and supports oak woodland with a grassland understory.
Lower Reach	Includes the mainstem of the Russian River downstream of its confluence with Dry Creek, excluding the Mark West Creek watershed. Most tributaries to this region enter the river from the northwest. These streams are subject to coastal fog conditions in the summer and flow through coniferous forest.
Estuary	Includes the mainstem of the Russian River from the river mouth, located near the town of Jenner, to approximately six to seven miles upstream in the Duncans Mills and Austin Creek areas. Occasionally, tidal influence occurs as far as 10 miles upstream to Monte Rio. Willow Creek Marsh occasionally receives saltwater influence.
Dry Creek Watershed	Includes Dry Creek and all of its tributaries between Warm Springs Dam to the confluence with the Russian River. The Dry Creek watershed is the major sub-basin on the western side of the middle reach of the Russian River.
Mark West Creek Watershed	This watershed includes Mark West Creek, the Laguna de Santa Rosa, Santa Rosa Creek, and their tributaries. This area is southeast of the Russian River and is generally warmer and drier than areas to the west of the river. The dominant vegetation is oak woodland. The cities of Santa Rosa and Windsor are in this region. The Laguna de Santa Rosa is south of Mark West Creek and includes the City of Rohnert Park.

and comment. The interim reports were presented before the PPFC and public comments were taken. The interim reports included:

- *Interim Report 1: Flood Control Operations at Coyote Valley and Warm Springs Dams* (ENTRIX, Inc. 2000a)
- *Interim Report 2: Fish Facility Operations* (FishPro and ENTRIX, Inc. 2000)
- *Interim Report 3: Flow-Related Habitat* (ENTRIX, Inc. 2002a)
- *Interim Report 4: Water Supply and Diversion Facilities* (ENTRIX, Inc. 2000c)
- *Interim Report 5: Channel Maintenance* (ENTRIX, Inc. 2001a)
- *Interim Report 6: Restoration and Conservation Actions* (ENTRIX, Inc. 2001b)
- *Interim Report 7: Hydroelectric Projects Operations* (ENTRIX, Inc. 2000b)
- *Interim Report 8: Russian River Estuary Management Plan* (ENTRIX, Inc. 2000d)

Additional documents developed for the evaluation of the hatchery operations include:

- *Hatchery and Genetic Management: Monitoring and Evaluation Plan and Benefit Risk Analyses for Russian River Fish Production Facilities* (FishPro and ENTRIX, Inc. 2002a)
- *Hatchery and Genetic Management Plans for Russian River Fish Production Facilities, Coho Salmon and Steelhead* (FishPro and ENTRIX, Inc. 2002b)

Based on effects identified in these analyses, a list of alternative actions was developed to reduce adverse effects to listed species. Potential effects of alternative actions were evaluated in *Alternatives: Evaluation of Management Actions* (ENTRIX, Inc. 2002d). This report was presented to the AWG, the Executive Committee, and to the PPFC for comment. Alternatives for flow management in the Russian River were considered in more detail in an addendum to the alternatives report (ENTRIX, Inc. 2003a).

Previous ESA actions on USACE activities are summarized below.

- September 30, 1997. NOAA Fisheries issued a BO and incidental take statement to USACE for repair work on the Emergency Water Supply Line (EWSL) at WSD and the annual pre-flood inspection at WSD.
- November 1997. USACE submitted a supplement to its July 1997 BA to NOAA Fisheries for a vibration analysis test on WSD outlet works. Due to safety concerns, the testing proceeded without a BO. NOAA Fisheries protested additional tests that USACE performed in March 1998.

- September 4, 1998. NOAA Fisheries issued a BO and incidental take statement to USACE for periodic inspections at WSD and CVD.

- June 1999. NOAA Fisheries issued a BO and incidental take statement to USACE for pre-flood inspections at WSD and CVD.

- February 23, 2000. NOAA Fisheries issued a letter of concurrence with a proposed action for emergency repairs to the EWSL at WSD to USACE.

- September 22, 2000. NOAA Fisheries issued a letter of not likely to adversely affect federally-listed species or habitat to USACE for reductions in flow to 25 cfs WSD and CVD during repairs to the EWSL at WSD and pre-flood inspections at CVD.

- September 22, 2000. NOAA Fisheries issued a letter of not likely to adversely affect federally-listed species or habitat to USACE for reduction in flow at WSD during sonic meter installation at WSD.

- October 11, 2000. NOAA Fisheries issued a BO to USACE for inspection and gate testing at CVD.

- August 27, 2001. NOAA Fisheries issued a letter of not likely to adversely affect federally-listed species or habitat to USACE for pre-flood inspection and repair of the outlet conduit at WSD.

- September 20, 2001. NOAA Fisheries issued a BO to USACE for a pre-flood inspection at CVD and inspection of City of Ukiah repairs to a bifurcation plate in the plenum chamber.

- September 25, 2002. NOAA Fisheries issued a BO to USACE for pre-flood inspection at CVD and repair work conducted by the City of Ukiah.

- August 14, 2002. NOAA Fisheries issued a letter of not likely to adversely affect federally-listed species or habitat to USACE for pre-flood inspection at WSD.

1.2.3 Recovery Plans in the Project Area

No recovery plans have been completed for Russian River stocks. Section 4(f) of the ESA requires NOAA Fisheries to develop and implement recovery plans for the conservation and survival of threatened and endangered species. Recovery plans for the Central California Coast (CCC) coho salmon, the CCC steelhead, and the California Coastal Chinook salmon are underway. All three species are included in the CCC recovery planning domain. A Technical Recovery Team has been convened to begin development of a recovery plan for the CCC that includes the Russian River stocks. Their first task is to establish the scientific framework for achieving recovery.

1.3 REGULATORY STATUS OF LISTED FISH SPECIES IN THE RUSSIAN RIVER

Biological resources of primary concern within the project area are coho salmon, steelhead, and Chinook salmon. These species are each listed as threatened under the ESA, although in the draft status review coho salmon are proposed to be upgraded to "endangered" (NOAA Fisheries 2003). Coho salmon and steelhead are native Russian River species, although there have been many introductions from other river systems (CDFG 1991). It is uncertain whether Chinook salmon is a native species of the Russian River (NMFS 1999). They have not been stocked since 1998 and continue to reproduce in the watershed. The naturally-spawning Chinook salmon are considered part of the California Coastal Chinook salmon population, which is protected under the ESA.

The pertinent Federal Register (FR) notices for these species are provided in Table 1-2.

Table 1-2 Federal Register Notices for the Salmonids of the Russian River

Species	Listing	Take Prohibitions	Critical Habitat
Coho Salmon	Vol. 61, No. 212, pp. 56138-56147 Oct. 31, 1996	Vol. 67, No. 6, pp. 1116-1133 January 9, 2002	Vol. 64, No. 86, pp. 24049-24062 May 5, 1999
Steelhead	Vol. 62, No. 159, pp. 43937-43954 Aug. 18, 1997	Vol. 65, No. 132, pp. 42422-42481 July 10, 2000	Vol. 65, No. 32, pp. 7764-7787 February 16, 2000
Chinook Salmon	Vol. 64, No. 179, pp. 50394-50415 Sept. 16, 1999	Vol. 67, No. 6, pp. 1116-1133 January 9, 2002	Vol. 65, No. 32, pp. 7764-7787 February 16, 2000
All Species			Vacated by April 30, 2002 court order[1]

[1]Critical habitat designations vacated by National Association of Home Builders v. Donald L. Evans, Civil Action No. 00-2799 (CKK).

NOAA Fisheries designated the Russian River and its tributaries as critical habitat for coho salmon, steelhead, and Chinook salmon (as described in the following sections). However, on March 11, 2002, NOAA Fisheries submitted a proposed settlement agreement in U.S. District Court that would rescind current critical habitat designations for 19 Evolutionarily Significant Units (ESUs), which included coho salmon, steelhead, and Chinook salmon populations in the Russian River basin. The court accepted the settlement proposed and remanded critical habitat designation to the NOAA Fisheries for reconsideration. NOAA Fisheries will undertake a new, more thorough analysis of the economic effects from designation of critical habitat. NOAA Fisheries is expected to proceed with re-issuing critical habitat designations after that analysis is complete.

For the BA, the evaluation of critical habitat described by NOAA Fisheries in the original critical habitat designations will be used to guide the evaluation of potential effects on habitat. The goal of regulation of critical habitat is to preserve habitat elements essential to the continued existence of the species. By using the approach outlined in the original critical habitat designation, the effects of the proposed project on habitat important to listed salmonids will be considered.

1.3.1 CENTRAL CALIFORNIA COAST COHO SALMON (*ONCORHYNCHUS KISUTCH*)

The CCC coho salmon ESU consists of all naturally spawned coho salmon populations from Punta Gorda (Humboldt County) south through the San Lorenzo River (Santa Cruz County), and includes coho salmon populations in the Russian River. This ESU also includes tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system.

The original critical habitat for the CCC coho ESU encompassed all accessible river reaches within the ESU (i.e., from Punta Gorda south to the San Lorenzo River). Critical habitat consisted of all waterways, substrate, and adjacent riparian zones below long-standing, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Adjacent riparian zones were defined on the basis of functional criteria rather than quantitative criteria. Specifically, the adjacent riparian zone is the area adjacent to a stream that provides the following functions: shade, sediment, nutrient or chemical regulation, streambank stability, and input of large woody debris (LWD) or organic matter. Areas specifically excluded from critical habitat included historically-occupied habitat upstream of specific dams identified in the FR notice (including WSD and CVD), and Indian tribal lands.

1.3.2 CENTRAL CALIFORNIA COAST STEELHEAD (*ONCORHYNCHUS MYKISS*)

The CCC steelhead ESU consists of steelhead occupying the Russian River and all river basins south to Aptos Creek in Santa Cruz County (inclusive). The CCC steelhead ESU also occupies drainages of San Francisco and San Pablo bays, eastward to the Napa River (inclusive), not including the Sacramento-San Joaquin River basin. The Russian River is the largest drainage in the CCC steelhead ESU. Steelhead reared at the DCFH were specifically excluded from the listed ESU in the final rule.

Original critical habitat for CCC steelhead encompassed the current freshwater and estuarine range inhabited by the ESU (i.e., from the Russian River south to Aptos Creek). Critical habitat consisted of all waterways, substrate, and adjacent riparian zones below long-standing, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). As with coho salmon, habitat excluded from critical habitat included river reaches upstream of several dams that block access to former anadromous habitats (including WSD and CVD), and Indian tribal lands.

1.3.3 CALIFORNIA COASTAL CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*)

The California Coastal Chinook salmon ESU consists of naturally spawned populations from Redwood Creek in Humboldt County south through the Russian River (inclusive). Hatchery populations are not considered essential for the recovery of the ESU and, therefore, are not listed at this time. In the final rule, NOAA Fisheries excluded Chinook salmon raised at DCFH from the California Coastal ESU. The Russian River basin presently contains the southernmost persistent population of Chinook salmon on the California coast.

The original critical habitat for the California Coastal Chinook ESU encompassed accessible reaches of all rivers (including estuarine areas and tributaries) within the current range inhabited by the ESU (i.e., from Redwood Creek in Humboldt County south through the Russian River). The critical habitat defined for Chinook salmon recognized the same exclusions as coho salmon and steelhead.

1.4 INSTITUTIONAL AGREEMENTS AND CONSTRAINTS

USACE, SCWA, and MCRRFCD conduct activities and operate facilities included in the Section 7 consultation under regulatory constraints and existing agreements, contracts, and vested property rights involving state, local, and federal entities, as well as individual property owners. Some agreements may constrain the extent to which, absent regulatory approvals and/or changes to the agreements, USACE, SCWA, and MCRRFCD can implement the conservation measures, reasonable and prudent measures, and conservation recommendations developed by NOAA Fisheries in the BO for the consultation. The flow management scenario proposed by the USACE and SCWA would also require additional regulatory approvals prior to implementation. This section describes the existing agreements that pertain to activities under consideration in this consultation.

1.4.1 POTTER VALLEY PROJECT

Much of the water that flows from the East Fork Russian River into Lake Mendocino originates in the Eel River watershed. Starting in 1908, water has been diverted from the Eel River to the East Fork Russian River through a hydroelectric tunnel. Now operated by Pacific Gas and Electric Company (PG&E), the project is called the Potter Valley Project (PVP). Scott Dam, forming Lake Pillsbury, was constructed in 1921 to provide water to operate the project through the summer.

In 1965 SCWA entered into an agreement with PG&E in anticipation of the Federal Energy Regulatory Commission (FERC) considering the relicensing of the PVP upon the expiration of PG&E's 50-year license to generate power (FERC Project No. 77). This agreement acknowledges that the continued operation of the PVP is important to the successful operation of the Coyote Valley Dam Project (CVDP) and SCWA's water transmission system. The agreement provides for the parties "cooperating in the public interest to secure, insofar as may be possible, such continuation of operation." For the PVP, SCWA is obligated to maintain riverbanks and a series of 15 check-dam structures (which were constructed as part of the PVP along the East Fork Russian River between Lake Mendocino and the Potter Valley powerhouse).

Article 39 of the existing FERC-issued PVP license, required a ten-year study of the effects of the project operations on downstream fish resources and provided for FERC consideration of changes to the required minimum Eel River flows. The minimum flows at issue are those necessary to protect and maintain anadromous salmon and steelhead trout populations in the Eel River. In February 1999 FERC issued a draft environmental impact statement (DEIS) for its planned reconsideration of Eel River minimum streamflows required downstream of the PVP. In May 2000 FERC issued a final environmental impact statement (FEIS). The FEIS evaluated the four alternatives addressed in the DEIS, and proposed a recommended flow regime.

In November 2002, NOAA Fisheries issued a final BO pursuant to the FERC action, which concluded that the recommended alternative in the FEIS would pose jeopardy to threatened salmonids in the Eel River. FERC action is pending on the requests for the preparation of a supplement to the FEIS and proposed modification to the recommended flow proposal. FERC has not yet made a final decision on a license amendment to establish new Eel River minimum streamflow requirements for the PVP. The outcome of these decisions may affect the quantity of water diverted from the Eel River to the East Fork Russian River.

1.4.2 Russian River Project

The Russian River Project was initiated to control flooding and develop water resources and recreational opportunities in the Russian River basin. The Russian River Project is a water diversion and storage project operated by SCWA and USACE to furnish water from the Russian River, the East Fork Russian River, and Dry Creek for domestic, industrial, municipal, irrigation (Lake Mendocino and Russian River water only), and recreational use. The Russian River Project consists of a number of elements, including CVD and WSD, associated channel stabilization works, recreational facilities, and fish production facilities to mitigate and enhance fisheries in the basin.

1.4.2.1 Coyote Valley Dam Project

On November 15, 1949 USACE issued and filed with Congress a report recommending the construction of CVD. In response, the California legislature created the Sonoma County Flood Control and Water Conservation District (later renamed the Sonoma County Water Agency) and the Mendocino County Flood Control and Water Conservation District (later renamed the Mendocino County Water Agency). Under this legislation authorizing construction of the dam, these agencies were to provide the local cooperation and funding required to construct the dam. The state legislation authorizing the formation of the local entities included a procedure to establish a more localized district (specific to the Russian River basin), which was established in 1956 as the Mendocino County Russian River Flood Control and Water Conservation Improvement District.

The CVDP was authorized by Section 204 of the federal 1950 Flood Control Act and published in House Document Number 585 by the 81st Congress. The Flood Control Act approved the plan in the Russian River basin for flood control and water conservation. The act appropriated a sum of $11.522 million for the initial stage of the plan and required that, prior to starting construction, local interests contribute the sum of $5.598 million to pay for the conservation benefits resulting from the project.

Public Law 404, approved February 10, 1956, authorized an additional $1.165 million federal appropriation toward the completion of the initial stage of the CVDP. In March 1956, SCWA made the required cash contribution in accordance with the authorizing act.

In December 1956, the MCRRFCD reimbursed SCWA $633,000 for a share of the water supply capacity of the reservoir. These payments satisfied the entire local cost-sharing obligation for the CVDP, except for the obligation to maintain erosion control measures. These measures were constructed as part of the CVDP at 91 locations along the Russian River from Healdsburg to Calpella.

The CVDP began storing water in 1958, and all facilities were completed in 1959. No formal written contract exists that defines the respective rights and obligations of USACE, SCWA, and MCRRFCD toward the CVDP. These rights and obligations are, however, documented in the legislation and various other writings. Such documentation includes resolutions of assurances by SCWA's Board of Directors, USACE's Water Control Manual for the CVDP (USACE 1984), as well as decisions of SWRCB (discussed in Section 1.4.3). Other components of the CVDP, which include hydroelectric projects, flood control structures in Mendocino and Sonoma counties, and fish production facilities, are described below.

City of Ukiah Hydroelectric Project FERC License

The City of Ukiah filed an application to FERC for a major license under Part 1 of the Federal Power Act on April 13, 1981, to construct, operate, and maintain the Lake Mendocino Power Project No. 2841. The FERC license was issued April 1, 1982 (FERC 1982) and will be in effect for 50 years. Additionally, USACE issued a license to the City of Ukiah on April 1, 1982 for the use of land and facilities incidental to the construction and operation of the hydroelectric project. Construction of the hydroelectric plant was completed in December 1986. It has a total generation capacity of 3.5 megawatts (MW) through two turbine and generator units.

Two problems had to be overcome in the development of the project. First, the outlet works needed to be retrofitted to withstand the full hydrostatic pressure of Lake Mendocino. Also, a bifurcation with an appropriate valve configuration needed to be installed to permit flows to bypass the turbine. Second, concerns about the dissolved oxygen (DO) content of water passing through the turbine resulted in a requirement to construct oxygenation facilities at the outlet. The terms of the FERC license dictate project operations including release of suitable bypass flows meeting water quality standards to maintain fish and wildlife habitat downstream during operations and maintenance of the hydroelectric facility.

Russian River Flood Control in Mendocino County

CVD is the primary flood control facility on the upper Russian River. The dam is located on the East Fork Russian River about 3 miles northeast of the City of Ukiah. CVD forms Lake Mendocino, which has a design capacity of approximately 122,500 acre-feet (AF) and drains an area of about 105 square miles, or approximately 7 percent of the total Russian River basin (USACE 1986b). USACE controls flood releases from CVD according to USACE's Water Control Manual detailing operational methods (USACE 2003).

When CVD was constructed, USACE recognized that flood control releases from Lake Mendocino would result in long-term bankfull flow, which would aggravate bank erosion. To offset potential erosion, USACE constructed stabilization works in the upper Russian River. These works were the first publicly-owned flood control facilities in the upper Russian River and were acquired by MCRRFCD as easements for the construction and maintenance of channel stabilization works associated with the CVD.

The channel stabilization works constructed by USACE in Mendocino County consisted principally of rock riprapped levees, earth levees, pile and wire revetments, steel jacks, and various other types of bank protective works. These were constructed at intermittent sites along a 15-mile reach of the Russian River extending from about 5 miles north of Hopland to Calpella between 1956 and 1963. The MCRRFCD maintains these works under an agreement with USACE according to specifications identified in a Mendocino County operation and maintenance manual (O&M manual) developed in 1965 (USACE 1965a).

Russian River Channel Maintenance in Sonoma County

The first channel stabilization works constructed by USACE in Sonoma County were transferred to SCWA for maintenance in November 1962. The works constructed along the Russian River included channel clearing, pilot channels, bank protection works consisting of anchored steel jacks, flexible fence training structures, and wire mesh-gravel revetments. These installations were made in 41 different locations in the Alexander Valley.

To permit the construction of erosion control works, SCWA acquired easements from most of the property owners from just south of the old Preston Bridge north of Cloverdale, to a point about 4 miles downstream from the Alexander Valley Bridge. These acquisitions began in 1962. Over the next ten years, USACE performed extensive bank protection and repairs within SCWA easements.

During this period, SCWA also sponsored the restoration of flood control works constructed by nonfederal interests in the upper Russian River. This restoration work was performed pursuant to Public Law 84-99 administered by USACE. SCWA provided 20 percent of the construction cost for these projects, either through direct funding or in-kind services. SCWA also agreed to provide necessary easements, which generally had already been acquired, and to hold and save the federal government free from damages.

Since 1972, SCWA has been responsible for maintaining the USACE channelization works associated with CVDP. SCWA is required to maintain these works in Sonoma County following specifications identified in the Sonoma County O&M manual (USACE 1965b).

Coyote Valley Fish Facility

Before the completion of CVD, it was believed that the higher streamflows resulting from operation of the project would mitigate for the loss of spawning and rearing habitat above the dam. After the project had been in operation, it became evident that the anticipated benefits (i.e., improved rearing habitat) would not be realized.

The Water Resources Act of 1974 enacted Section 95 of Public Law 93-251, which directed USACE to compensate for fish losses on the Russian River attributed to the operation of CVD facilities in Mendocino County. This mitigation was accomplished, in part, by modification and expansion of the fish hatchery at WSD. The construction of the fish facility at CVD and expansion of the DCFH facilities began in 1991 and both were operational by 1992. The mitigation program involves capturing returning adult steelhead at Coyote Valley Fish Facility (CVFF), collecting eggs and fertilizing them, then transporting the fertilized eggs to the DCFH for incubation and rearing to yearling size. These fish are then returned to CVFF for imprinting and release.

Currently, CDFG operates both DCFH at WSD and CVFF at CVD under amendment to Cooperative Agreement DACW05-82-A-0066 as amended September 30, 1991 (USACE-CDFG 1991). The period of this agreement began in October 1991 and extended through September 1999. Yearly extensions have been granted to CDFG since 1999.

1.4.2.2 Warm Springs Dam Project

The Warm Springs Dam Project (WSDP), including downstream channel improvements, was authorized by Section 203 of the federal Flood Control Act of 1962 and published in House Document 547, by the 87th Congress. A contract between the federal government and SCWA for water storage space in Lake Sonoma was entered into in December 1964 and was amended on October 1, 1982. Under this contract, SCWA is obligated to repay the federal government the full cost of the joint-use facilities allocated to water conservation (water supply). SCWA must also pay its pro-rata share of the annual operation and maintenance costs of the WSDP. SCWA’s share of these costs are funded through a property tax assessment on land in Sonoma County. The costs of operating and maintaining the fish production facility and recreation facilities at WSD/Lake Sonoma are borne by the federal government.

Warm Springs Hydroelectric Project, FERC License and USACE Agreement

During construction of WSD, USACE conducted studies evaluating the feasibility of installing a hydroelectric plant. When the project was completed, it included minimum provisions for the future installation of a turbine. On July 27, 1983 SCWA filed an application to FERC for a major license under Part 1 of the Federal Power Act to construct, operate, and maintain Warm Springs Dam Hydroelectric Project Number 3351. FERC issued SCWA a license to operate the facility on December 18, 1984. USACE issued a license to SCWA on December 18, 1984 for the use of land and facilities incidental to the construction and operation of the hydroelectric project effective April 1, 1985. Construction of the hydroelectric plant was completed in December 1988 at a cost of $5 million. The plant has a total generation capacity of 2.6 MW through a single turbine and generator unit.

SCWA entered into an agreement with USACE on December 22, 1989 providing for SCWA to operate and maintain the hydroelectric project. On January 4, 1989, SCWA entered into an agreement with PG&E, clarifying and standardizing the operating procedures for the project. An amendment to the power purchase agreement between SCWA and PG&E was entered into on January 31, 1989, which fixed the delivery capacity at 1.246 MW. The terms of the FERC license and the USACE agreement dictate project operations.

The FERC license contains a specific flow release schedule for WSD. The minimum flow releases from WSD required by FERC are met or exceeded as part of water supply operations conducted by SCWA or releases made to satisfy D1610. D1610 requires higher minimum instream flow from December 1 through March 31. Water deliveries during April to September generally exceed the FERC minimum instream flows.

Each year between 11 and 15 million kilowatt-hours of power are produced and sold by SCWA to PG&E. In addition, SCWA also receives a “capacity payment” for the value of the power generation made available during the peak power demand season. To receive capacity payments, SCWA must generate a constant minimum of 1.246 MW during June, July, and August, which are the peak demand months for power consumption (PG&E 1984). Some short-term exceptions to this power requirement are allowed for circumstances that are beyond SCWA's control. This contract expires in December 2008.

Dry Creek Channel Maintenance

Erosion control projects on Dry Creek were constructed by USACE in conjunction with the WSDP (USACE 1991). These projects were installed at 15 different locations along Dry Creek. They were constructed under three different contracts between 1981 and 1989. Project components include: grouted riprap sills, rock riprap bank stabilization, installation of steel piles with timber planking, derrick stone toe protection, grade control structures, concrete weirs, and a stilling basin. As in the case of the flood control works constructed by USACE on the Russian River, SCWA is responsible for the maintenance and operation of the works on Dry Creek and maintains these facilities following specifications identified in the WSDP O&M manual (USACE 1991).

Operation of Don Clausen Fish Hatchery

The design and construction of the DCFH was an original component of the WSDP. The proposed design of the hatchery at WSD was a part of the USACE Design Memorandum No. 12 Fish and Wildlife Facilities, dated December 1972 (USACE 1972). Following recommendations by USFWS and CDFG, hatchery operations were revised by Supplement No. 1 to Design Memorandum No. 12 in December 1974 (USACE 1974). Supplement No. 1 dictates the release of minimum flows to support adequate spawning and rearing habitat in Dry Creek. Between April 1 and November 30, the minimum flow is 25 cubic feet per second (cfs). For the remainder of the year, flows were not to be less than 75 cfs depending on riparian diversions and storage levels in the reservoir. Minimum flow rates for Dry Creek were increased in 1986 by SWRCB Decision 1610 (D1610).

D1610 is summarized in Section 1.4.3, and the resultant flow management is discussed in Section 2.1.4.

As described earlier in Section 1.4.2.1, the Water Resources Act of 1974 initiated USACE construction of fish facilities at WSD and CVD. Additional fish production capabilities were included in the hatchery program goals to enhance harvest opportunities for Chinook salmon and coho salmon (USFWS 1978).

DCFH went into service on October 1, 1980 under the control of CDFG in accordance with an USACE-CDFG Agreement dated June 8, 1979 and amended May 1, 1982. This agreement was subsequently modified to provide additional compensation for losses to fish spawning and rearing habitat above both WSD and CVD. DCFH was expanded and linked with CVFF. Both the DCFH expansion and CVFF became operational in 1992.

1.4.3 WATER RIGHTS AND SWRCB DECISION 1610

The SWRCB has statutory authority over appropriative water rights in California. Appropriative water right permits and licenses specify authorized maximum rates of direct diversion, diversion to storage, and rediversion. Direct diversion refers to water diverted from a stream for immediate use (within 30 days). Diversion to storage refers to water diverted from a stream and held for more than 30 days. Rediversion refers to water that has first been diverted to storage, then released back into a stream and diverted again (rediverted) for beneficial use at a point downstream. Riparian water rights are derived from ownership of land that borders a stream or lake. Riparian owners may directly divert natural flow for beneficial purposes on riparian lands without an appropriative water right permit. If the diverted water is to be stored for use in another season or used on nonriparian lands, then an appropriative water right permit must be obtained. In general, riparian users must share available supplies among themselves. Their riparian rights, generally remain with the riparian land when the lands are sold.

SCWA holds water right Permit 12947A for storage of water at Lake Mendocino and for direct diversion and rediversion of water originating in the East Fork Russian River at its Wohler/Mirabel diversion points. Under this permit, the combined direct diversion and rediversion rates are limited to 92 cfs (average monthly rate) and 37,544 acre-feet per year (AFY). SCWA holds water right Permit 16596 for storage of water at Lake Sonoma and for direct diversion and rediversion of 180 cfs from the Russian River at Wohler/Mirabel. SCWA also holds water right Permits 12949 and 12950 for direct diversion of 20 cfs and 60 cfs, respectively, at Wohler/Mirabel. The combined direct diversion and rediversion rates under all four of SCWA's water right permits are limited to no more than 180 cfs (116.3 million gallons per day [mgd]) and 75,000 AFY (October 1 to September 30).

SCWA controls and coordinates water supply releases from the CVD and WSD projects in accordance with the provisions of D1610, adopted on April 17, 1986 (see Section 2.5). On March 8, 1985, SCWA and CDFG entered into an agreement specifying the minimum flows necessary for in-stream beneficial uses in both Dry Creek and the Russian River. D1610 incorporated the minimum streamflows contained in the agreement. The agreement retained the minimum flow of 25 cfs in the East Fork Russian River from CVD to the confluence with the Russian River. From that junction to Dry Creek, the minimum Russian River flow is specified as 185 cfs from April through August and 150 cfs from September through March during *normal* conditions, with reductions allowed during *dry* hydrologic conditions. From Dry Creek to the Pacific Ocean, the minimum flow is specified as 125 cfs during *normal* conditions with reductions to 85 cfs and 35 cfs, respectively, during *dry* and *critically dry* conditions. In Dry Creek, the minimum flow is specified as 75 cfs from January through April, 80 cfs from May through October, and 105 cfs in November and December during *normal* conditions. During *dry* and *critically dry* conditions, these are reduced to 25 cfs from April through October, and 75 cfs from November through March.

SCWA has an appropriative water rights application and several petitions pending before the SWRCB. The following sections summarize the details of the pending application and petitions.

1.4.3.1 Petitions to Add Points of Diversions for Russian River Customers

On June 10, 1991 SCWA filed petitions with the SWRCB to add three wells owned by the Windsor Water District (a predecessor to the Town of Windsor, which was incorporated in 1992) as additional authorized points of diversion and rediversion in SCWA's water right Permits 12947A, 12949, 12950, and 16596. These petitions were filed to implement an agreement that SCWA entered into with the Windsor Water District on January 8, 1991. The agreement became operative on January 4, 1994, when the SWRCB issued an order granting the petitions.

An agreement with Russian River County Water District (RRCWD) for the sale of water was executed March 14, 1991. On January 7, 1992, SCWA submitted petitions to add two wells owned by the RRCWD as authorized points of diversion and rediversion in SCWA's water right permits. The substantive sections of the agreement with RRCWD became operative on May 10, 1994, when the SWRCB issued an order granting the petitions.

The purpose of both of these sets of petitions (for Windsor and RRCWD) was to authorize water use by both districts under SCWA's water right permits during times when no unappropriated water is available in the Russian River. This can occur during drier periods, when water in the Russian River that has been released from storage in Lake Mendocino or Lake Sonoma is necessary to supply some diversions. SWRCB's order allows SCWA to provide stored "project water" to several municipal suppliers (referred to as Russian River Customers) in Sonoma County.

SCWA entered into similar agreements with the City of Healdsburg on November 17, 1992 and the Camp Meeker Recreation and Parks District on July 9, 1996. SCWA filed petitions with SWRCB on May 20, 1998 to add additional authorized points of diversion and rediversion for these entities' wells to the SCWA's appropriative water rights permits. SCWA entered into an agreement with Occidental Community Services District on April 23, 2002 and filed a petition with the SWRCB on October 14, 2002. These agreements will become effective if SWRCB issues orders granting SCWA's petitions.

1.4.3.2 Petitions to Add Points of Diversion for New SCWA Facilities

SCWA filed petitions with the SWRCB on November 18, 1999 to add seven new points of diversion and rediversion to SCWA's water right Permits 12947A, 12949, 12950, and 16596. The new points of diversion and rediversion consist of seven new water production wells, which were constructed in 1995 as the Russian River Well Field Development Project.

SCWA filed petitions with the SWRCB on March 17, 1999 to add Collector No. 6 (currently under construction), which is located in SCWA's Wohler diversion area, as a new authorized point of diversion and rediversion in Permits 12947A, 12949, 12950, and 16596.

On October 7, 1999 SCWA filed an application with the SWRCB for a new appropriative water right permit for the direct diversion of 72 cfs of Russian River water at SCWA's existing intakes at Wohler and Mirabel and a new Collector (No. 6), currently under construction. The purpose of this application is to appropriate additional water for SCWA's WSTSP. In its application and related petitions to amend SCWA's water rights, SCWA requested a combined limit for diversion and rediversion of 101,000 AFY at a maximum rate of 252 cfs under Permits 12947A, 12949, 12950, and 16596, and the new permit. On July 14, 2000 the SWRCB published notices of SCWA's petitions that were filed on May 20, 1998, March 17, 1999, and October 7, 1999.

1.4.3.3 Water Rights in Upper Russian River (Mendocino County)

Mendocino County's Ukiah and Hopland valleys, which extend from the confluence of West and East forks of the Russian River below CVD to the Mendocino County line, comprise the service area of the MCRRFCD. The MCRRFCD holds water right Permit 12947B, which authorizes the consumptive use of 8,000 AFY of Lake Mendocino and Russian River water. The MCRRFCD acquired this right, which has a priority date of 1949, in 1961 as a consequence of its reimbursement to SCWA of part of the local cost of the CVDP.

Many individual water users divert Russian River water and redivert "project water" from the Russian River under the MCRRFCD's water right. Rediversion of CVD releases under the MCRRFCD's water right is different from diversions of natural flow water by individuals holding their own water rights. These water-right holders include riparian diverters, who have a right to the "natural flow" of the river, and appropriative diverters, who have rights to the water that would be in the river in the absence of the CVDP (including natural flow and water imported into the basin via the PVP). Water-right holders in Sonoma County also may divert up to a total of 10,000 AFY of CVPP water under a reservation.

MCRRFCD reports direct diversion and rediversion of CVDP water from the Russian River by numerous individuals to the SWRCB as required under their water rights permit.

This reporting generally includes mainstem diverters in Mendocino County. The amounts reported are estimates of the quantities of water diverted. MCRRFCD estimates the quantity of natural flow and PVP water available and applies that amount of water to satisfy the demands of pre-1949 diverters. If there is inadequate natural flow and PVP water available to satisfy the needs of all those claiming pre-1949 diversion priorities, then MCRRFCD reports the additional diversions as project water rediverted under its own water right. The precise quantity of water diverted under valid pre-1949 priority claims is uncertain because this quantity varies with the crop types cultivated on the recognized pre-1949 places of use. The quantity of water diverted in Mendocino County prior to 1949 was estimated to be 8,100 AF annually. This number likely represents an upper limit to the amount of water that may be diverted and used under pre-1949 rights.

1.4.3.4 Water Rights in Lower Russian River (Sonoma County)

In addition to the rights for CVD/Lake Mendocino water held by SCWA and the MCRRFCD under Permits 12947A and 12947B, respectively, 10,000 AFY of CVDP water is reserved for rediversion for domestic and agricultural uses in Sonoma County. Water from this reservation is diverted and reported to the SWRCB by the individual water-right holders. As in Mendocino County, many diverters in Sonoma County also hold pre-1949 rights.

Municipal diverters in Sonoma County other than the SCWA include the cities of Cloverdale and Healdsburg, the Town of Windsor, Geyserville Water Works, the RRCWD near Forestville, the Sweetwater Springs Water District in Guerneville and Monte Rio, and Camp Meeker Recreation and Parks District. Some of the municipalities divert under SCWA water rights.

1.4.4 Russian River Estuary Management Responsibilities

A barrier beach (sandbar) forms across the mouth of the Russian River, closing the Estuary and forming a lagoon. Historically, Sonoma County Department of Public Works breached the sandbar at the mouth when it closed to avoid flooding and property damage to adjacent lands (primarily in the Town of Jenner).

In 1992, Sonoma County, with assistance from the California State Coastal Conservancy, formed the Russian River Estuary Interagency Task Force (RREITF) to develop a management plan for the Estuary. The plan recommended a mechanical breaching program that reduced adverse environmental effects and protected private property from flooding. The management plan was adopted by the Sonoma County Board of Supervisors in 1995, and SCWA assumed responsibility for its implementation.

There have been, on average, five to seven mechanical breaching events per year. The sandbar has been breached using a bulldozer when water levels in the Estuary are between 4.5 and 7.0 feet in elevation. The goal is to manage water levels at the Jenner gage at or below 7.0 feet. This level was selected to avoid flooding in Jenner, minimize periods of poor water quality, and to avoid high flushing velocities following breaching. Water levels are determined from the automated tide recorder. The breaching schedule varies from year to year, depending on the frequency of closure of the Russian River mouth.

SCWA manages the Estuary in compliance with a number of state and federal permits and agreements. These include authorizations from California State Parks, the California State Lands Commission, the California Coastal Commission, CDFG, RWQCB, and USACE. Specifically, these permits and agreements include:

- California State Parks temporary use permit
- State Lands Commission General Lease for Public Agencies (PRC 7918.9)
- California Coastal Commission Coastal Development Permit (No. 2-01-033)
- CDFG 1601 Agreement (No. III-1176-96)
- RWQCB Waste Discharge Requirement (Order No. 8173-WDR)
- USACE Clean Water Act Section 404 Permit (File No. 221211N)

1.4.5 SCWA River Monitoring Stations

The River Monitoring Stations Project was initiated in 1991 in response to requirements set forth by the California Department of Health Services (CDHS) as part of SCWA's domestic water supply permit (System No. 4910020, Water Permit No. 02-91-017). The project is intended to continuously monitor Russian River water to detect contamination prior to potential delivery to SCWA customers. The project includes collecting data on DO, pH, temperature, turbidity, depth, and conductivity simultaneously from five river monitoring stations between Hopland and Guerneville.

1.4.6 SCWA Flood Forecasting

On September 30, 1986, the Sonoma County Board of Supervisors and SCWA Board of Directors adopted Resolution No. 86-2070A approving development of a Flood Hazard Mitigation Plan for Sonoma County. Section III of this plan requires SCWA to monitor changes in the Russian River floodway elevations and to alert the county's Director of Emergency Services when predetermined water levels are reached at various locations. Flood forecasting is done by SCWA in collaboration with the California Department of Water Resources (CDWR) using data from CDWR's River Forecasting Center. Flood forecasting predicts flood-crest levels in the lower Russian River so that evacuation plans can be made and steps taken to minimize property damage. Section IV of the plan requires SCWA to construct flood-hazard mitigation projects on a continuous basis. SCWA has agreements with the U.S. Geological Survey (USGS) and the California Department of Water Resources. These 1992 agreements are to maintain various stream-gaging stations on the Russian River (USGS 1992) and have access to information systems (USGS 1987) that provide stream-gage height and discharge information. This information is necessary for flood forecasting activities as well as managing flow releases to maintain water supply.

1.4.7 SCWA Zones 1A and 5A Flood Control Maintenance Responsibilities

In 1958, under the authority of SCWA's enacting legislation, the formation of nine geographical zones, each encompassing a number of hydrologic subareas in the watershed, was proposed as a means to finance, construct, and maintain flood control works in Sonoma County. Over the next several years, six of the nine flood control zones were formed, including two in the Russian River basin (Zones 1A and 5A). Zone 1A encompasses the Mark West Creek, Santa Rosa Creek, and Laguna de Santa Rosa subareas, which includes the cities of Santa Rosa, Sebastopol, and Windsor. Zone 5A encompasses the Russian River from the mouth to the Old Redwood Highway Bridge at Healdsburg, which includes the Austin Creek and Guerneville subareas.

Laguna de Santa Rosa, Santa Rosa Creek, and Mark West Creek are tributaries of the lower Russian River. The principal flood control facilities that have been constructed in the lower Russian River basin are located within Zone 1A. These flood control facilities were constructed as the Central Sonoma Watershed Project by SCWA under an agreement with the Santa Rosa Soil Conservation District and the U.S. Department of Agriculture, Soil Conservation Service. This project was approved under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666 as further amended). The work plan for this project was approved in 1958 (USSCS 1958) and the project was constructed over the next 25 years. An operation and maintenance agreement was approved on February 12, 1974 (USSCS 1974). The project included the construction of five floodwater retarding structures and the straightening, shaping, and stabilization of portions of 13 waterways to protect urban areas from flooding.

Zone 5A encompassed the Russian River from the mouth to the Old Redwood Highway Bridge at Healdsburg. Zone 5A was formed principally to finance construction of local drainage projects within the Vacation Beach area, Forest Hills Subdivision, and Riverlands Subdivision areas. No major flood control works were ever financed by the zone along the lower Russian River. Maintenance work along the lower Russian River consists primarily of periodically removing fallen trees when requested by landowners.

SCWA's flood control policies are identified in a series of resolutions adopted by SCWA's Board of Directors. Resolution DR 10073 adopted in July 1964 established that SCWA would only accept responsibility for the maintenance of drainage facilities that satisfy SCWA's adopted standards and specifications, which include flood control design criteria.

These standards and specifications were formally adopted by Resolution DR 17860 in November 1966, and were revised by Resolution 42127 adopted in September 1983. In its operation and management of flood control works, SCWA adheres to numerous contractual agreements, state and federal regulations, the conditions established for each flood control zone as defined in the *Engineers Report for Creation of Benefit Zones* (dated November 26, 1958 and modified by Board resolutions regarding engineering, operation, and maintenance policies), and the conditions defined in the *Agency Report on Benefit Assessments for Flood Control Purposes Within Zones 1A and 2A* (SCWA 1987-2001).

Overall, SCWA has permissive drainage easements along more than 150 miles of natural waterways in Sonoma County, and has constructed flood control channels in both Flood Control Zones 1A and 5A. Work is done following SCWA standards and specifications as described above, as well as under conditions specified by CDFG (under the Streambed Alteration Agreement, Section 1601 of the Fish and Game Code), the RWQCB (under Section 401 of the Clean Water Act, or waste discharge requirements specified in the state Porter-Cologne Act), and USACE (under Section 404 of the Clean Water Act). Right-of-ways are either owned in fee or SCWA holds a drainage easement. To perform this work in natural channels, SCWA has individual agreements and access easements with more than 1,100 property owners throughout Sonoma County. These agreements and the flood control design criteria discussed above largely specify the kinds of channel maintenance activities that SCWA performs.

1.4.8 Agreement for Water Supply

On October 24, 1974, SCWA entered into an agreement with the cities of Cotati, Petaluma, Santa Rosa, Rohnert Park, and Sonoma, and the Forestville, North Marin, and Valley of the Moon water districts (“water contractors”). Since 1974, the agreement has been amended eleven times, most recently in 2001. The Eleventh Amended Agreement for Water Supply superseded the Tenth Amended Agreement for Water Supply and Construction of Russian River-Cotati Intertie Project and authorized the implementation of the WSTSP (SCWA 2001a).

The Eleventh Amended Agreement authorizes SCWA to (1) construct or acquire additions to the existing transmission system sufficient to meet increased delivery entitlements established by the agreement for the water contractors and to make the deliveries authorized by the agreement to the Marin Municipal Water District (MMWD); (2) construct additional Russian River water production facilities up to a total capacity of 168.9 mgd so that the total water production capacity available at all times is not less than the average daily delivery to the regular customers and MMWD (excluding surplus water and water in excess of entitlements) during the month of highest historical use plus 20 mgd; (3) construct emergency wells with capacities to be determined by the Water Advisory Committee; (4) construct additional storage facilities (up to a total capacity of 174.3 million gallons) to the extent necessary to maintain a quantity of water in storage equal to 1.5 times the average daily delivery to the regular customers except North Marin Water District during the month of highest historical use; and (5) replace existing facilities and construct additional facilities, related buildings, and appurtenances as necessary to insure the reliable and efficient operation of the transmission system and to insure that the quality of the water delivered complies with all applicable state and federal water quality requirements. The Eleventh Amended Agreement specifies annual water delivery limits for each water contractor, except the Forestville County Water District.

The additional facilities authorized by the Eleventh Amended Agreement include an aqueduct generally paralleling the Russian River-Cotati Intertie; an aqueduct generally paralleling the south part of the Petaluma Aqueduct from the Russian River-Cotati Intertie to Kastania Reservoir; an aqueduct generally paralleling the Sonoma Aqueduct; an aqueduct connecting the Kawana Springs and Ralphine reservoirs; transmission line pumping plants necessary to regulate flows to storage facilities; 55.5 million gallons of additional tank storage; 56.9 mgd of additional Russian River water production capacity; water-treatment facilities; and additional groundwater wells.

The Eleventh Amended Agreement remains in effect until June 30, 2036, or, if any revenue bonds are outstanding on June 30, 2036, until such date as all revenue bonds shall have been paid in full. The Eleventh Amended Agreement provides that SCWA shall enter into renewal agreements for periods not to exceed 40 years each with any or all of the water contractors requesting the same for water supplies within the delivery capabilities of SCWA's transmission system. This would be at a cost no greater than SCWA's operation and maintenance costs and unreimbursed capital costs allocated on a proportionate use basis.

The Eleventh Amended Agreement also requires the water contractors: 1) to implement or use their best efforts to secure the implementation of urban water conservation best management practices (BMPs) as established by the California Urban Water Conservation Council, or 2) to implement or use their best efforts to secure the implementation of alternative water conservation measures that secure at least the same level of water savings. The water contractors and SCWA must also implement or use their best efforts to secure the implementation of any water conservation requirements that may be added as terms or conditions of SCWA's appropriative water rights permits or licenses, or with which SCWA must comply under any applicable regulation or law. The Eleventh Amended Agreement cannot be amended without the consent of all the water contractors.

1.4.8.1 MMWD Agreements

On July 3, 1975 SCWA entered into an agreement with the MMWD, entitled the “Offpeak Water Supply Agreement.” This agreement provided for the delivery of water to MMWD not to exceed the annual amount of 4,300 AF, using excess capacity in SCWA’s transmission system available during the off-peak months of the year. The water was conveyed to MMWD’s distribution system via the North Marin Aqueduct pursuant to a wheeling agreement between MMWD and North Marin Water District that was entered into on September 11, 1974. The Offpeak Water Supply Agreement was amended three times, first in 1984, second in 1988, and thirdly, in 1996, when SCWA entered into a Supplemental Water Supply Agreement with MMWD.

The Third Amended Offpeak Water Supply Agreement increased the total quantity of water subject to a “take or pay” requirement from 2,500 to 4,300 AFY. It extended SCWA's obligation to release water from storage for use by MMWD to include the full year rather than just during the off-peak period. It conformed the agreement to language in Amendment No. 9 to the Agreement for Water Supply and Construction of the Russian

River-Cotati Intertie Project that required the Russian River Conservation Charge paid by MMWD be credited to SCWA's Russian River Projects Fund. It added a new Russian River Projects Charge to be paid by MMWD in lieu of Sonoma County property tax money (other than the WSD tax levy proceeds) that is applied by SCWA for maintaining the Russian River water supply.

1.4.9 Recovery Planning MOU

In 2001, NOAA Fisheries, CDFG, FishNet 4C, and the County of Humboldt entered into an MOU that established a collaborative process for recovery planning in the North-Central California Coast recovery planning domain. That MOU set forth an approach for local jurisdictions to support the identification and implementation of recovery goals established by the Technical Recovery Team. Signatories have agreed to participate in the NOAA Fisheries recovery planning process, as described in *Recovery Planning for West Coast Salmon* dated October 1999, and the National Oceanic and Atmospheric Administration (NOAA) *Recovery Planning Guidelines* dated September 1992 (NOAA 1992).

This section describes the environmental baseline condition within the Russian River watershed. NOAA Fisheries defines the environmental baseline in a Section 7 consultation as:

> *…an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area.* (USFWS and NMFS 1998).

The environmental baseline provides the foundation for developing proposed changes in operations to benefit listed fish species in the Russian River watershed (described in Section 3). Understanding existing conditions is crucial to evaluating the potential effects of the proposed project on listed salmonids.

This Section 7 consultation is being conducted under the guidance of the Executive Committee, established by the 1997 MOU. The Executive Committee has defined the environmental baseline as conditions that existed before the MOU was signed, December 31, 1997. Project actions implemented since then, as well as current actions that would be continued, are part of the proposed project (Section 3). The potential effects of these actions on listed species will be evaluated in the Draft BA. Section 2 describes the historical and existing environment within the Russian River watershed, the status of the listed species and their life history, and USACE and SCWA facilities and operations under baseline conditions.

Section 2.1 describes the regional setting, including information on hydrology, dams, local land uses, historical channel dynamics, habitat, and water quality. Knowledge of the basin's hydrology is critical to understanding both historic and current conditions.

Section 2.2 describes the biological resources in the watershed and physical habitat conditions. Information on the species distribution, abundance, and other factors necessary to their survival is included as background for the analyses to be presented in the Draft BA. Results of biological monitoring conducted within the watershed, as well as genetic studies, are presented.

The remaining sections describe USACE and SCWA activities and operations under baseline conditions. The effects of the activities and operations under baseline conditions were evaluated in detail in *Interim Reports 1* to *8* (ENTRIX, Inc. 2000a, b, 2001a, b, c, d, 2002a, FishPro and ENTRIX, Inc. 2000). These reports are available on USACE's web site (http://www.spn.usace.army.mil/ets/rrsection7). Results of these analyses are included in the descriptions of the activities and operations, as they are factors affecting the species environment. Section 2.10 integrates these factors to identify the issues affecting listed fish species throughout the watershed.

2.1 REGIONAL SETTING

2.1.1 WATERSHED OVERVIEW

California's Russian River drains a watershed of nearly 1,500 square miles centered 60 miles northwest of San Francisco, and empties into the Pacific Ocean near Jenner (Figure 2-1). The watershed is bordered on the west by the Coast Range, and on the east by the Mayacamas Mountains. Geologically, the area is characterized by northwest-trending mountain ranges and intervening alluvial valleys. Hills and mountains comprise 85 percent of the basin, and valleys make up the remaining 15 percent. Unstable Franciscan lithology underlies most of the mountainous regions, and landslides are common. The Russian River flows southward from its headwaters through small valleys and past the cities of Ukiah, Hopland, and Healdsburg before turning west at Mirabel Park. Joining the river near that point are flows from Mark West Creek and Laguna de Santa Rosa, which drain much of the southern portion of the basin. From Mirabel to the Pacific Ocean, low mountains along both banks confine the river for 22 miles. Major tributaries of the Russian River include the East Fork, Big Sulphur Creek, Maacama Creek, Dry Creek, and Mark West Creek/Laguna de Santa Rosa.

Lying within a region of Mediterranean climate, the watershed is divided into a fog-influenced coastal region and an interior region with hot, dry summers. The basin-wide mean annual precipitation is 41 inches, with a range of 22 to 80 inches (USACE 1982). The greatest precipitation occurs at high elevations and in coastal mountains near Cazadero, while the lowest precipitation falls in the southern Santa Rosa Plain (USACE 1982). Approximately 93 percent of the annual runoff occurs from November to April (USACE 1986a-b) during Pacific frontal storms.

Above the East Fork confluence, the Russian River is uncontrolled by dams and drains an area of 100 square miles to the north and northwest. The East Fork Russian River drains an area of 105 square miles to the northeast of the Forks, but is controlled by CVD and Lake Mendocino less than one mile above the East Fork/mainstem confluence. The East Fork Russian River receives interbasin transfers of water from the Eel River via the PVP.

2.1.2 DAMS

2.1.2.1 Potter Valley Project (PVP)

The PVP is located on the Eel River and diverts water to the East Fork Russian River above Lake Mendocino. This discussion of the PVP is provided solely as background information for this BA. The action agencies do not control operation of the PVP.

The PVP is comprised of Scott Dam and Lake Pillsbury, Cape Horn Dam, a diversion tunnel from the Eel River to the Russian River, and the Potter Valley hydroelectric power plant. Since 1908, PVP water diversions from the Eel River have generated power, irrigated agricultural land in Potter Valley, and augmented summer flows in the Russian River. PG&E purchased the PVP in September 1929. The quantity of water that can be diverted to the Potter Valley power plant is affected by the releases required to maintain

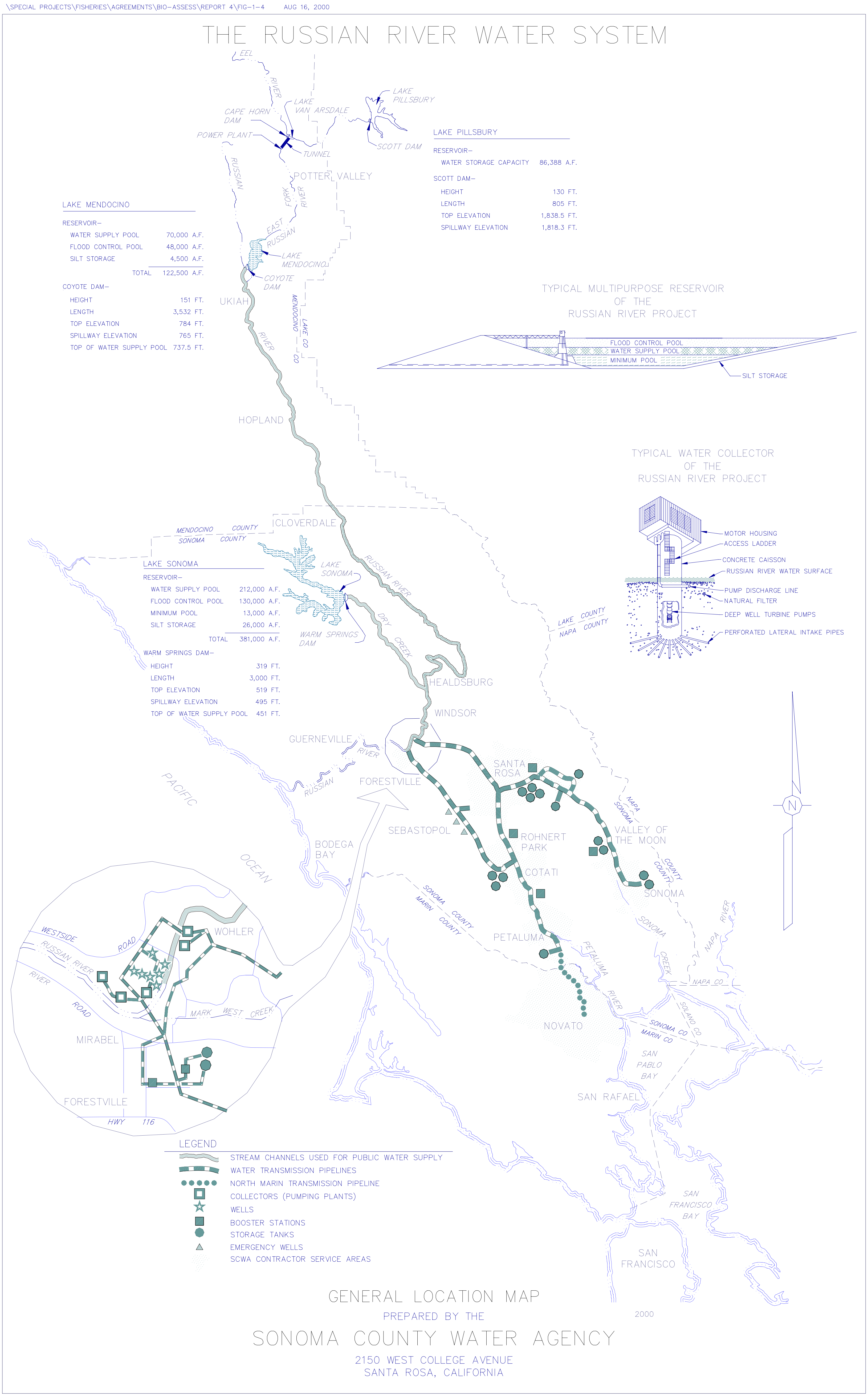

Figure 2-1 The Russian River Water System General Location Map

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the fishery in the Eel River. Diversion quantity is also affected by an agreement with the U.S. Forest Service to maintain high reservoir levels in Lake Pillsbury until Labor Day of each year for recreational use. The Potter Valley diversion tunnel has a maximum capacity of 350 cfs. From 1922 to 1992, diversions from Lake Pillsbury to the East Fork Russian River watershed averaged 159,000 AFY.

Releases from Lake Pillsbury and the PVP are the subject of a separate Section 7 consultation between NOAA Fisheries and FERC (NMFS 2000a). Changes to the release criteria and minimum flow provisions in the 1983 FERC license for the PVP have been proposed and are the subject of an Environmental Impact Statement (EIS) issued in May 2000 by FERC. PG&E has voluntarily reduced diversions so, if implemented, the proposed action would not substantially reduce the quantity of water currently diverted to the Russian River basin via the PVP.

The PVP diversion significantly altered the natural streamflow in the Russian River. Between construction of Scott Dam in 1922 and construction of CVD in 1959, Eel River water stored in Lake Pillsbury and diverted to the East Fork Russian River helped provide significant base flows throughout the year. Presently, operation of the PVP is not coordinated with the operation of CVD and is not subject to SCWA or USACE control.

2.1.2.2 Coyote Valley Dam and Lake Mendocino

Lake Mendocino is impounded by CVD on the East Fork Russian River, about 0.8-mile upstream of the confluence with the Russian River. Lake Mendocino is owned and operated by the USACE San Francisco district office, while the Sacramento Water Management District provides complete engineering support for the San Francisco District water management program. Information on the authorizing legislation is provided in Section 1.4.2.

The CVD project is a multipurpose project providing a high degree of flood protection to areas below CVD and supplying water needs for domestic, industrial, and agricultural uses. Releases from CVD maintain flow in the East Fork Russian River during the summer months when the river would otherwise be dry, or nearly dry. Water releases from CVD are designed to supply an adequate flow of water to the Russian River during the summer months to supply water user needs and satisfy instream flow requirements. Winter operations include water storage until the dedicated flood storage space is reached and releases are made for flood control. CVD and Lake Mendocino facilities and operation are described in detail in Section 2.3.1.

2.1.2.3 Warm Springs Dam and Lake Sonoma

Lake Sonoma is impounded by WSD at the confluence of Warm Springs Creek and Dry Creek, about 10 miles northwest of the city of Healdsburg. Lake Sonoma became fully operational in 1984. It is a multipurpose facility operated by USACE for the primary purposes of flood control, water conservation, and recreation. WSD and Lake Sonoma facilities and operation are described in detail in Section 2.4.1.

2.1.2.4 Inflatable Dam

SCWA's inflatable dam and diversion facilities are located on the Russian River just upstream of the Mirabel area at river mile (RM) 22. (The "RM" designation refers to the distance from the mouth of the river at the Estuary, upstream to the site referenced.) This inflatable dam is a key component of SCWA's diversion facilities. It consists of a rubber bladder attached to a permanent concrete foundation. When inflated, the dam is 11 feet tall. The backwater impounded by the dam raises upstream water levels to improve infiltration and facilitate diversion operations. Fish ladders are located on both banks to provide fish passage.

Additional details of the inflatable dam facilities and operation are presented in Section 2.5.

2.1.2.5 Fish Barriers

Natural Barriers

Obstacles including shallow water, cascades and falls, log jams, and other natural barriers limit upstream migration of adult salmonids into the upper reaches of tributaries. Locations of some barriers have been documented (CDFG 2002).

Permanent Dams

Willow County Water Diversion Dam, owned by the Willow County Water District, is located at RM 88 in Ukiah. This permanent dam is located at RM 88 in Ukiah, may affect fish passage into the uppermost reaches of the Russian River, where the best steelhead spawning and rearing habitat of the river is located (CDFG 1991). The dam is constructed of rocks and slabs of old concrete sidewalks, and is used for diverting water for irrigation (Winzler and Kelly 1978).

Seasonal Dams

Every summer, several temporary dams are placed across the Russian River and its tributaries to form pools (Winzler and Kelly 1978). Most pools are for recreational use, but several supply water. Their location may vary from year to year. Dam installation typically begins in late May and most are removed by early September.

Four of the temporary dams have been regularly installed on the middle and lower Russian River during the summer recreation season since the 1930s. These dams are located at Del Rio Woods, Healdsburg, Johnson's Beach, and Vacation Beach. Historically they were usually installed by the end of May and usually removed by mid-September. Each year, these dams are removed before the salmon and steelhead spawning migrations, although low numbers of Chinook salmon begin upstream migration in September. The outmigration of salmonid smolts during the spring may be delayed by these facilities.

The Del Rio Woods Dam is located at RM 35 and is 12 feet tall. The dam is a 300-foot-wide permanent sill structure that accommodates flashboards in summer. The Del Rio Woods Recreation District operates this dam for summer recreation.

The Healdsburg War Memorial Beach Dam is a 16.5-foot-tall seasonal summer dam located at RM 32. The Healdsburg Dam has a concrete sill and removable flashboards with steel support beams. A separate Section 7 consultation between USACE, SCWA, and NOAA Fisheries was conducted in 2000 to address construction and operation of a fish ladder at the dam. The fish ladder was completed in 2001, and provides upstream passage for American shad and enhances passage conditions for salmonids when the flashboards are down. Prior to 2001, the flashboards were installed around May 20 (RMA 1997). Consistent with the terms of the BO, the flashboards are currently installed near the end of June and removed the first week following Labor Day. Gravel material is placed on the sides of the sill structure to complete the impoundment. The County of Sonoma, which owns the Healdsburg Dam, was responsible for constructing the fish ladder. SCWA assisted the county with fishway plan preparation, design, and construction. SCWA is the principal party responsible for the operation and maintenance of the ladder.

The temporary summer dam at Johnson’s Beach is located at RM 14 in Guerneville and is 8 feet tall. It has permanent concrete and steel piers and flashboards, which are installed during the summer. The dam also contains a fishway, which is constructed into the face of the dam. The Sonoma County Regional Parks Department maintains the dam.

The temporary summer dam located at Vacation Beach at RM 12 is 8 feet tall. It includes a concrete base and collapsible steel support beams that remain in the Russian River during the winter. Wooden flashboards are installed during the summer. A fishway is built into the dam to permit fish passage when the flashboards are in place.

Road Crossings

Five temporary gravel road crossings on the Russian River and additional crossings on the tributaries provide cross-river access during the dry season. These crossings are:

- Russian River at Washington School Road in Asti
- Russian River at Odd Fellows Road near Korbel Champagne Cellars
- Russian River at Summer Crossing Road in Guernewood Park
- Russian River at Vacation Beach Avenue at Vacation Beach

A semi-permanent crossing is installed on Dry Creek near its confluence with the Russian River. In addition to the above crossings, numerous other temporary crossings are installed in the Russian River by gravel mining companies. Two temporary crossings are installed by Shamrock Materials, Inc., near the confluence of Big Sulphur Creek and the Russian River. The exact locations of the gravel mining crossings vary from year to year, depending on the morphology of the Russian River and gravel operation needs. The crossings have bridges or culverts to allow for streamflow. CDFG biologists report that summer road crossings have little or no effect on fish passage (CDFG 1991), but they may reduce the quality of fish habitat (Hopkirk and Northen 1980).

Culverts

A basin-wide assessment of all Sonoma and Mendocino county-owned culverts was conducted in 2001 and 2002 (Taylor 2000, cited in CDFG 2002). Study protocols were consistent with recent NOAA Fisheries guidelines for salmonid passage at stream crossings (NMFS 2000a). Paved roads run parallel to large tributaries in all reaches of the basin and numerous small dirt and paved roads in smaller canyons have thousands of culverts or fords at crossings. CDFG will focus initial restoration efforts on sites that have the best biological benefit for federal- and state-listed populations of anadromous salmonids (CDFG 2002).

Temperature and Chemical Barriers

Thermal barriers can be caused when low flows, lack of riparian vegetation, impaired hydrologic regimes, or point-source discharges of warm water increase water temperatures above thermal limits of listed fish species. CDFG has identified temperature barriers in long sections of streams within the Big Sulphur Creek watershed, where natural geothermal activity occurs. CDFG has also identified temperature barriers in the Maacama Creek watershed (McDonnel Creek subwatershed), where limited riparian vegetation occurs on long stretches of stream.

Chemical barriers are usually caused by a point-source discharge that makes water quality unsuitable. Wastewater releases may cause migration barriers and/or increased straying (CDFG 2002). Investigations are ongoing in the Russian River watershed.

2.1.3 LOCAL LAND USES

2.1.3.1 Urban Development

Urban development began in the late 1800s. Currently, approximately six percent of the land area is developed with residential, industrial, and commercial properties. Communities along the Russian River include Ukiah, Hopland, Cloverdale, Asti, Geyserville, Healdsburg, Rio Nido, Guerneville, Monte Rio, Duncans Mills, and Jenner. Communities located on tributaries to the Russian River include Windsor, Larkfield/Wikiup, Santa Rosa, Rohnert Park, Cotati, Sebastopol, Occidental, Camp Meeker, Forestville, and Graton. Supporting transportation routes include U.S. Highway 101 and State Highways 1, 12, 20, 116, 128, and 175, in addition to several county roads and bridges. The Northwestern Pacific Railroad generally parallels the Russian River from Healdsburg north to Calpella.

Current and future development and construction in the basin are based on approved general plans of the various incorporated communities, and on general and specific plans of Mendocino and Sonoma counties. Light industry and commercial development is a growing trend within and near Ukiah and Santa Rosa. Primary industrial activities in the watershed include production and processing of timber products, wine products, and agricultural and animal products; gravel mining and processing; and energy production. Recreation is also a major industry in the watershed, including hiking, camping, canoeing, swimming, and fishing.

2.1.3.2 Wastewater

There are multiple points of discharge from wastewater treatment plants to the Russian River and its tributaries. These discharges are covered under permits issued by the RWQCB. Nonpoint source discharges from failing septic systems and other sources along the Russian River have not been fully identified. However, communities without sewers along the lower Russian River are known to include failing septic systems The Water Quality Control Plan for the North Coast (Basin Plan) adopted by RWQCB in 1993 has established policy and an implementation schedule for controlling wastewater discharges to the Russian River. Exceptions are made on a case-by-case basis and are defined in the National Pollutant Discharge Elimination System (NPDES) permit for each discharger.

2.1.3.3 Gravel Mining

Since the mid-1800s, gravel mining on the Russian River has taken place in the area between Fitch Mountain in Healdsburg and the Wohler Bridge. Instream areas where multiyear permits may be approved have been designated in Alexander Valley between Jimtown Bridge and Cloverdale, and along Big Sulphur and Austin creeks. Gravel mining increased sharply in the late 1940s when demand for sand and gravel increased and active flood protection projects were being constructed by USACE. Historical accounts suggest that the Russian River was dredged to a depth of 30 feet to 60 feet along the entire reach from Healdsburg to Wohler Bridge. Between 1980 and 1995, about 42 million tons (a yearly average of 2.8 million tons) of gravel was removed by instream and terrace mining operations. Within Sonoma County, need-based projections for aggregate from 1991 to 2020 range from 75 million to 171 million tons.

Three extraction methods have been used in the basin: in-channel mining, terrace or pit mining, and quarry mining. In-channel methods remove material directly from the stream channel. Gravel is often skimmed from bars or excavated directly from active-channel deposits emerging during low flows. Terrace or pit mining removes gravel from historic or active flood plain deposits. The pits are separated from the active channel by buffer zones of varying width. Some pits are up to 44 feet deeper than the adjacent river channel elevation (Steiner 1996). Quarry mining uses sites away from the stream and its floodplain, and has little direct effect on the stream channel. A substantial indirect effect of quarry mining is the demand for water, which can be as much as 20,000 gallons per day (gpd) for a single operation (Steiner 1996).

The Aggregate Resource Management Plan (ARM Plan), adopted by Sonoma County in 1980 and revised in 1994, established terrace and instream mining locations, policies, and standards for operations and reclamation (EIP Associates 1994). The objective of the ARM Plan is to manage quarry production on a sustained-yield basis for high-quality uses, and incorporate instream resource protections to reduce bank erosion, maintain flood-flow capacities, protect adjacent land uses, and minimize effects on fisheries, vegetation, and wildlife. According to the ARM Plan, instream mining in the form of gravel bar skimming will continue to be allowed at levels that balance the rate of aggradation and degradation.

In 1998, as part of the 1994 ARM Plan, SCWA monitored riparian and aquatic habitat along the Russian River to assess effects of multiyear bar skimming operations. Preliminary results indicated that riparian habitat is characterized by a prevalence of immature habitats, such as immature forests and riparian scrub, that may result, in part, from flood scour and the small size of the active floodplain. Fifty-two percent of the existing riparian stands were established before or during 1947 (remnant habitat), and most of the habitat loss on outer/immediate banks and terrace areas has resulted from development of the floodplain, especially since 1987. Within the active channel and floodplain, losses of gravel bar vegetation have probably been due to thalweg shifts, flood scour, gravel bar skimming, and flood control-related channel clearing and stabilization activities. A comparison of survey results for 1991 and 1998 shows the total length of run-habitat in these reaches may be increasing, and the total length of pool-habitat may be decreasing.

NOAA Fisheries issued a BO for instream mining in the Russian River by Syar Industries and Shamrock Materials, Inc. (NMFS 2001 and 2002, respectively). Conservation measures were provided in the project description and in the terms and conditions of the BO to minimize adverse effects of the activities on listed species.

In Mendocino County, there is currently no resource management plan for aggregate mining in and along waterways. However, the Mendocino County Water Agency is in the process of developing a gravel management plan for the Russian River in Mendocino County. Currently, instream mining only takes place at four locations in Mendocino County. Three of these locations are on the mainstem of the Russian River below Ukiah, and one instream mining area is located in Redwood Valley on the West Fork Russian River (CDWR 1984).

2.1.3.4 Timber Harvest

Vast stands of redwood trees fueled an intensive logging industry in the late 1800s and early 1900s in the Russian River watershed. Although logging has decreased, there are currently many active Timber Harvest Plans (THPs) in effect on the Russian River watershed. Many are located near tributaries of the Russian River in the more mountainous regions. Most logging operations occur along the lower river section of the Russian River west of Guerneville, and along the upper river section near Ukiah. Since 1990, several hundred acres have been logged in the Russian River watershed.

2.1.3.5 Agriculture

The Russian River watershed is primarily an agricultural area, with an emphasis on vineyard and orchard crops. Major orchard crops consist of prunes, pears, and apples, but other crops such as cherries and walnuts are also produced. There is considerable grazing by cattle and sheep in some areas. The watershed contains both dry and irrigated pasture, and hay and grains are grown. Irrigation water is generally needed from May through early October. Large amounts of water are diverted in the spring for use in protecting vineyards from frost (USACE 1998b). SCWA estimates that in the Sonoma County portion of the watershed, 26,000 acres currently produce wine grapes (another several thousand acres have been planted but are not yet producing), and 20,700 acres produce fruits and vegetables. Range land for cattle and sheep grazing in Sonoma County is estimated between 100,000 and 150,000 acres. Most land currently in agricultural production has been grazed or cultivated for many years. Substantial areas of undeveloped lands that were not in agricultural production have been converted to vineyards in recent years. However, a lack of suitable land and the increasing trend of urbanization are limiting factors to future agricultural production expansion.

2.1.4 Hydrology

Surface water hydrology in the Russian River basin strongly reflects the area's Mediterranean climate: warm, dry summers and cool, wet winters. Greater than 82 percent of the precipitation falls between the months of November to March (Western Regional Climate Center 2003). Snowfall is uncommon except in the highest elevations; most precipitation comes in the form of rain.

Under historical, predevelopment conditions, flows in the mainstem would crest soon after rainstorm peaks. About 80 percent of the annual discharge occurred during winter (Ritter and Brown 1971). Historic maximum winter flows were many times greater in magnitude than winter baseflows, and far higher than summer flows, which often dropped to 20 cfs or less.

Facilities owned by PG&E and USACE have altered historical flows in both the mainstem Russian River and Dry Creek. Surface water hydrology changed in terms of timing, frequency, magnitude, and duration of flows. A portion of the winter runoff was stored behind dams for release during dry months. Average monthly flows decreased for winter/spring periods, and increased for summer/fall periods. Water imported to the basin substantially increased the amount of water available during the summer season.

Early in the twentieth century, diversions of Eel River water through the PVP to the East Fork Russian River boosted springtime flows, but did not augment late summer flows. Since construction of Scott Dam in 1922, flow in the Russian River downstream of the East Fork has been augmented by water from the Eel River, especially in the summer months. PG&E diverts approximately 159,000 AF of water, on average, from the Eel River into the East Fork Russian River at the Potter Valley diversion northeast of Ukiah for power generation.

CVD influences mainstem flow patterns year-round. Dam operations diminish flood peaks, redistribute winter flows, and increase summer flows above Healdsburg by as much as 200 cfs.

WSD substantially modified flow in Dry Creek. Lake Sonoma is operated primarily for flood control, water supply, and recreation. Flood control operations reduce peak flood discharges on Dry Creek and the Russian River below Healdsburg. During stormflow events, WSD is operated to attempt to limit Russian River flows at Guerneville to less than 35,000 cfs.

Water stored behind WSD is released throughout the dry months to support downstream water demands of domestic, municipal, and industrial users. Minimum instream releases under D1610 are also made, in part, to support recreational users. Resulting flows are substantially higher than the pre-project conditions, approximating 100 cfs or more. USGS flow records indicate that prior to the construction of the dam, Dry Creek went dry during the summer.

Augmented summer flows have increased the amount of water that flows to the Estuary, thereby altering it from historical conditions. Before construction of major water projects, mainstem flows often dropped to 25 cfs or less, and at times, ceased altogether. Under these conditions, the Estuary likely remained closed to the ocean for weeks or months at a time. Currently, inflows to the Estuary could result in periodic flooding of low-lying properties. As a result, the barrier sandbar is artificially breached, exposing the Estuary to ocean tides (see sections 1.4.4 and 2.6). Local fisheries experts believe artificial sandbar breaching and high estuary inflows have altered habitat conditions for listed fish species from historical conditions (J. Smith, San Jose State University pers. comm. 2001, B. Coey, CDFG, pers. comm. 2000).

Groundwater hydrology has likely been altered by water development, although these changes have gone undocumented. Bankfull and overbank flows are now less common in reaches influenced by flood control operations at WSD. Furthermore, extraction of groundwater is likely to result in localized effects. Such effects may have changed sections of the Russian River from a gaining reach (groundwater flows from adjacent aquifer adds to riverine flow) into a losing reach (water from river flows into aquifer, reducing river flow). At the same time, increased summer baseflows have increased the height of water tables and the extent of saturated soils within mainstem channel banks.

2.1.4.1 Stream Gaging

The U.S. Geological Service (USGS) collects stage and discharge data at 17 gages along the Russian River and various tributaries, and collects stage data only at an additional 5 gages. Historically, the USGS collected streamflow data at 16 gages besides the 22 currently in operation. USGS has also collected sediment data at eight sites and water quality data at five sites. Table 2-1 shows the average annual discharge at selected locations. Streamflow on the East Fork Russian River near Ukiah represents approximately 50 percent of the average annual flow expected at Hopland, 25 percent of the average annual flow at Healdsburg, and 15 percent of the average annual flow at Guerneville. Average annual discharge on Dry Creek since construction of WSD (period 1983-2001) is less than the unregulated (period 1960-1983) average annual flow condition.

Table 2-1 Average Annual Discharge at Selected Sites in the Russian River Watershed

Site[a]	Drainage Area (mi^2)	Period of Record	Avg. Ann. Discharge[b] (cfs)
East Fk. RR near Ukiah	105	1952-2001	340
RR near Hopland	362	1940-2001	708
RR near Healdsburg	793	1939-2001	1,432
RR near Guerneville	1,338	1939-2001	2,295
Dry Creek near Geyserville	162	1960-1983	350
Dry Creek near Geyserville	162	1983-2001	301[c]

[a]Source: USGS gage data at stations near Ukiah, Hopland, Guerneville, and Geyserville.

[b]Average annual discharge was calculated by averaging flows at each USGS gaging station.

[c]1983-2001 represents the period WSD operations affected flow in Dry Creek.

2.1.4.2 High Flows

The Russian River watershed responds rapidly to variations in rainfall, often resulting in flash floods. On February 17, 1986, peak flows were 26,100 cfs at Hopland, 71,100 cfs at Healdsburg, and 102,000 cfs at Guerneville. Peak flood flow on Dry Creek near Geyserville prior to regulation by WSD was 32,400 cfs on January 31, 1963, and after regulation, the peak flow was 7,600 cfs on January 8, 1995 (USGS gage data).

During the rainy season (November through May), natural streamflow rather than reservoir releases accounts for most of the flow of the Russian River. CVD has only a slight effect on winter flood flows at Healdsburg because it controls only 7 percent of the drainage area of the Russian River watershed (USACE 1986a). A study by the USACE in 1986 evaluated the effect of CVD on the flood of 1964 (a 25-year flood-event). The results indicate that dam operations substantially affect flood peaks at Hopland (29 percent reduction), but have limited effects at Guerneville (7 percent reduction).

The 1.5-year recurrence interval flood (i.e., the flood flow that occurs on average every 1.5 years) is significant because the associated flows are most effective, over the long-term, in forming and maintaining channel morphologic characteristics (Leopold 1994). Typically, the bankfull discharge (when flows reach the top of the channel bank) has an approximate recurrence interval of 1.5 years in the annual flood series. Flows greater than the 1.5-year-flood event exceed the channel capacity and overflow the floodplain. The bankfull channel capacities at Ukiah, Hopland, and Guerneville are 7,000 cfs, 8,000 cfs, and 35,000 cfs, respectively (USACE 1986a). Table 2-2 shows the channel capacity and 1.5-year floods at two of these locations.

Table 2-2 Russian River Channel Capacity and 1.5-Year Flood

Location	Channel Capacity	1.5 Year Flow
Hopland	8,000 cfs	12,000 cfs
Guerneville	35,000 cfs	30,000 cfs

The 1.5-year flood at Hopland is approximately 12,000 cfs in the regulated condition and 14,500 cfs in the unregulated condition. By comparison, at Healdsburg the 1.5-year recurrence interval flood is nearly identical in the regulated and unregulated conditions (about 25,000 cfs). At Guerneville, the 1.5-year recurrence interval under regulated conditions (as influenced by both CVD and WSD) is approximately 30,000 cfs, and under unregulated conditions is approximately 37,000 cfs.

In both the regulated and unregulated conditions, the 1.5-year flow at Hopland is greater than the 8,000-cfs channel capacity, and would result in over-bank flows. The 1.5-year regulated flow condition at Guerneville is approximately equivalent to the bankfull channel capacity. Thus, on average, every two out of three years the flow can be expected to result in one flood that is at least equal to, or greater than, the channel capacity in these reaches.

WSD has significantly reduced flood flows in Dry Creek to less than 25 percent of the pre-dam rates (Swanson 1992). The floods of 1963 and 1986 on Dry Creek were of comparable sizes, but flow regulation by WSD reduced the 1986 peak flood flow by approximately 83 percent (Swanson 1992). The 1.5-year flood was about 11,000 cfs before construction of the dam, but has been reduced to about 2,500 cfs under regulated conditions. A five-year recurrence interval flood on Dry Creek was more than 24,000 cfs before regulation by WSD, and is approximately 7,500 cfs today.

2.1.4.3 Low Flows

On April 17, 1986, the SWRCB issued D1610 on SCWA's appropriative water rights permit applications (SWRCB 1986b). The permits issued by the SWRCB under SCWA's applications incorporated, as permit terms, an agreement between SCWA and the CDFG that specified the minimum flows necessary for instream beneficial uses on both Dry Creek and the Russian River (see Section 1.4.3). These permit terms dictate minimum flow in Dry Creek and in the Russian River. Flow regulation under D1610 is described in Section 2.5.2.

2.1.5 Historical Channel Dynamics and Sediment Transport

A number of management practices have altered channel characteristics in the Russian River and Dry Creek. These practices include streamside and in-river gravel mining, channelization, flood control projects, removal of riparian vegetation, operation of dams and PVP interbasin water transfers. In general, habitat has become less diverse and less favorable to native fish species (Hopkirk and Northen 1980). The amount of riparian vegetation in the Russian River watershed has greatly decreased since the early 1800s because of agricultural practices, livestock grazing, urban development, flood control, gravel mining, and road construction.

2.1.5.1 East Fork Russian River

There is approximately 0.8 miles of habitat in the East Fork Russian River between CVD at Lake Mendocino and its confluence with the mainstem Russian River. There is a lack of gravel and cobble recruitment below the dam with some gravel deposition existing near the confluence. This section of river is characterized by channelized, vertical embankments downstream of the dam. There is a lack of instream cover and structure in this reach. Exotic species, including striped bass, have been observed below CVD (B. Cox, CDFG, pers. comm. 2000).

2.1.5.2 Upper Reach Russian River

In the Ukiah Valley, the Russian River largely consists of high-velocity run-habitat. Here the river flows in a relatively straight channel and is lined with dense riparian vegetation. Gravel extraction occurs within the river channel and on the floodplain of the Ukiah Valley. Instream gravel mining and trapped sediments in Lake Mendocino on the East Fork caused up to 16 feet of channel bed degradation between the mid-1960s and the mid-1980s at the City of Ukiah, based on historic survey data (Swanson 1992). Based on sedimentation data provided by SCWA, Swanson (1992) estimated that Lake Mendocino had trapped, on average, 21,000 tons of gravel sized sediments annually.

Downstream of the Ukiah Valley, the Russian River enters entrenched reaches through Hopland to Cloverdale and the Sonoma-Mendocino County line before entering the 20-mile-long alluvial Alexander Valley. In the Alexander Valley, the river flows in a wide, shallow, sinuously braided channel that is laterally migrating, causing bank erosion (Swanson 1992). Gravel extraction occurs in-channel, and vineyard development has been taking place on the floodplain. Both degradation and aggradation have been measured at river cross-sections in the valley during the past two decades (Swanson 1992).

2.1.5.3 Middle Reach Russian River

The Russian River flows out of the Alexander Valley near the Jimtown Bridge and enters Digger Bend, a sinuous canyon where the channel is confined and bounded by alluvial terraces. About one mile east of Healdsburg, the river enters a 10-mile-long alluvial valley (RM 33 to RM 23), known as the “middle reach.” Dry Creek enters the Russian River about one mile downstream of Healdsburg, and the Wohler Bridge defines the lower boundary of the reach. In the middle reach, the Russian River is a generally straight channel that flows through a two-mile-wide floodplain. Land use is dominated by vineyards and active or abandoned gravel extraction pits. In the middle reach between the Healdsburg Dam and the Wohler Bridge, the channel has the capacity to carry up to about the 10-year-flood event. This capacity is due to a lowering of the channel bed by an average of 10 feet (Swanson 1992), and is a result of land-use practices, including grazing and agriculture since the early 1800s and intensive gravel mining since the 1940s.

2.1.5.4 Dry Creek

Similar to the Middle Reach of the Russian River, Dry Creek has undergone considerable geomorphic changes, particularly since 1940, when intensive instream gravel extraction was occurring (Swanson 1992). Gravel extraction continued in Dry Creek until about 1979. Severe erosion, degradation, and channel-widening occurred on Dry Creek during this period as a result of channel incision of the Russian River by 18 feet at the confluence and the instream gravel extraction on Dry Creek.

2.1.5.5 Lower Reach Russian River

Downstream of the Wohler Bridge, the Russian River flows westerly through a narrow valley bounded by mountains. The channel is relatively straight and deep, with a low floodplain where the town of Guerneville is situated on the north side of the river. Guerneville is subject to frequent flooding, on average once every five years. Gravel and sandbars are common along the channel. Below Guerneville, the Russian River flows into its coastal estuary near the confluence with Big Austin and Willow creeks.

2.1.5.6 Laguna de Santa Rosa and Mark West Creek

These tributaries to the Russian River are characterized as low-gradient, and at times, intermittent. Agriculture is common near the banks of Laguna de Santa Rosa and Mark West Creek. A lack of canopy and instream cover results in high water temperatures. The banks are channelized for flood control and bank stabilization. Warmwater fish species are common in both streams (R. Benkert, SCWA, pers. comm., 2001).

2.1.5.7 Estuary

The Russian River Estuary (Estuary) near Jenner extends approximately six to seven miles from the river's mouth at the Pacific Ocean, upstream to Duncans Mills and Austin Creek in western Sonoma County. Tidal influence has occurred as far as 10 miles upstream to Monte Rio (Russian River Estuary Interagency Task Force [RREITF] 1994). A barrier beach (sandbar) forms naturally across the mouth of the river periodically during the dry season, impounding water and forming a lagoon. The sandbar opens naturally when hydraulic conditions in the Russian River and Pacific Ocean change, or when it is artificially breached. When the sandbar is open, the Estuary is open to tidal mixing. A detailed description of the structure and function of the Estuary is presented in Section 2.6.

2.1.5.8 Other Tributaries

Remaining Russian River tributaries can be grouped into two geographic sets: (1) tributaries to the Estuary; (2) tributaries to the mainstem above the Estuary. Habitat conditions for the tributaries in each set are discussed in the following sections.

Tributaries to the Estuary Reach

Tributaries to the Estuary include Willow Creek, Freezeout Creek, Dutch Bill Creek, Austin Creek, and their tributaries. These streams have been degraded from logging and grazing activities, but at one time they supported coho salmon and steelhead, as well as other species. Many of these streams maintain a grade-level connection with the mainstem. Habitat conditions in these streams are typified by excessive fine sediment and degraded riparian vegetation. Additionally, the stream morphology has been greatly altered by the deposition of excessive sediment in the lower-gradient reaches closest to the Russian River. Larger systems, such as Austin Creek and its tributaries, generally contain habitat that is in good condition. However, the mainstem of Austin Creek has been used for gravel extraction. In the past, many summer dams were installed every year but have since been removed. Dutch Bill Creek is parallel to the Bohemian Highway and numerous houses and businesses are situated along its length.

Many of these tributaries (Freezeout, Willow, and Austin creeks, and their tributaries) were surveyed for habitat conditions during summer and fall months from 1994 to 1996 (CDFG 1998b). Tributaries were slightly to moderately incised in their middle and upper reaches. Of the 60 to 70 surveyed miles of lower tributaries below Guerneville, 72.4 percent were classified as a Rosgen channel type F or G (Rosgen 1996), which are the likely natural channel types in this watershed. (F-type channels are characterized by moderate-to-high width-to-depth ratios and moderate-to-high sinuosity. G-type channels are characterized by low width-to-depth ratios and moderate sinuosity.) This reach originally was likely a wide, shallow, braided channel (Swanson 1992). The overall dominant stream cover was mostly boulders, although root masses and woody debris were found in the upper tributaries. Canopy cover in the surveyed streams tended to be high, and of the 14 tributaries surveyed, nine had over 80 percent canopy cover and four had 50 percent to 80 percent cover. East Austin Creek was the only creek surveyed that had a canopy cover below 50 percent. Instantaneous water temperatures measured during the surveys ranged from a low of 46°F (8°C) to a high of 76°F (24°C). Summer maximum water temperatures averaged in the mid-60°s F. The percentage of pools based upon stream length ranged from 32 percent in Freezeout Creek to 6 percent in Ward and Mission creeks. The average pool-habitat of all surveyed tributaries was 22 percent.

Tributaries to the Mainstem above the Estuary

Santa Rosa Plain Tributaries

The streams of the Santa Rosa plain include Laguna de Santa Rosa, and Atascadero, Mark West, Santa Rosa, and Windsor creeks, and their tributaries. These tributaries drain the area to the south and east of the Russian River between Guerneville and Healdsburg. Most of these tributaries flowing across the Santa Rosa plain are low-gradient streams, and because urbanization has occurred in the area, many are managed as flood control channels. Habitat quality here is poor as a result of levees, armored stream banks, dredging activities, past practices of removing riparian vegetation, and warm summer water temperatures. Tributaries to the middle reach of the Russian River between Healdsburg and the Wohler Bridge, where gravel mining occurs, have undergone incision in their lower reaches as the mainstem has incised up to 18 feet at some locations.

Streams in the Mark West Creek watershed and their tributaries were surveyed during summer and fall months of 1994 to 1996 (CDFG unpublished data, CDFG 1998b). The surveys found that the Santa Rosa plain tributaries had incised channels. About half of the 48.3 miles surveyed were classified as well-entrenched, low-gradient stream. Instantaneous water temperatures measured during the surveys in the Santa Rosa plain tributaries during July through November ranged from 50°F to 74°F (10.0°C to 23.3°C). Summer maximum water temperatures averaged in the mid-60°s F (approximately 18°C).

Canopy cover was relatively high, ranging from 60 percent to 90 percent. Dominant stream cover varied, and included boulders, aquatic vegetation, and root masses. In the streams surveyed, the ratio of pool-habitat to stream length varied from 6 percent to 47 percent. The tributaries of the Santa Rosa plain consisted of an average of 27 percent pool habitats. Habitat quality in upper Santa Rosa Creek and Mark West Creek in the foothills east of Santa Rosa was excellent.

Middle Reach Tributaries

Major tributaries of the middle reach of the Russian River include Maacama, Sausal, Big Sulphur, and Dry creeks. Most of the tributaries on the west side of the middle reach are minor streams, except for Dry Creek and its tributaries. Dry Creek and its lower tributaries, Felta and Mill creeks, have also undergone incision in their lower reaches as a result of mining-induced incision of the Russian River channel and other activities. Cloverdale and Healdsburg are the main urban centers in the area.

Habitat surveys were conducted on west- and east-side tributaries (Maacama and its tributaries, Felta and Mill creeks, and Palmer Creek and its tributaries) during the summer and fall months of 1996 to 1997 (CDFG 1998b). Fish population surveys and site-specific habitat assessments were conducted in Sausal and Big Sulphur creeks in the mid-1970s (PG&E 1975). Habitat in more than 61 percent of the 33.7 miles of tributaries in the middle reach showed indications of incision. This incision occurs mainly in the lower reaches of these tributaries. These channels were characterized by multiple channels with very high width-to-depth ratios in the lower reaches of Maacama Creek. This type of channel offers poor quality habitat and may interfere with fish migrating into the system. Instantaneous water temperatures measured during the surveys ranged from 49°F to 80°F (9.4°C to 26.7°C) from June through November. Summer maximum water temperatures averaged in the mid-60°s F. The dominant cover type consisted of boulders and some root masses. The average percentage of pool based on stream length ranged from 5 percent to 55 percent, with an average of 27 percent. Canopy cover for the surveyed streams in the middle reach ranged from 48 percent in Maacama Creek to 91 percent in Thornton Creek. Most of these tributaries had canopy covers greater than 50 percent.

Upper Reach Tributaries

Comminsky, Pieta, McNab, Robinson, Feliz, McClure, Ackerman, and Forsythe creeks and the East Fork are the main tributaries of the upper reach of the Russian River, upstream from the Mendocino-Sonoma County line. Ukiah and Hopland are the major urban centers. Most of the East Fork Russian River lies upstream of CVD. McNab, Robinson, and Ackerman creeks were surveyed for aquatic habitat during the summer to early winter months from 1994 to 1997 (CDFG 1998b). Pieta Creek was sampled for fish populations and habitat characteristics in the mid-1970s (PG&E 1975). The aquatic habitat survey found that over 60 percent of the channels were incised. Between June and December, instantaneous water temperatures ranged from 51°F to 77°F (10.6°C to 25.0°C). Summer maximum water temperatures during the surveys averaged in the mid-60°s F (approximately 18°C). Dominant substrate for these streams is mainly gravel in the lower reaches, and cobble, boulders, and bedrock in the upper reaches. The dominant cover in Ackerman and Robinson creeks is boulders, and the dominant cover in McNab Creek is root masses. The average pool-habitat ratio based on stream length for the three creeks is 24 percent (ranges from 19 percent to 30 percent).

2.1.6 Habitat Conditions in the Russian River Watershed

Habitat conditions have been assessed within portions of the watershed over the last few decades. The most recent information comes from stream-habitat surveys conducted by CDFG and cooperating agencies such as SCWA. The CDFG Draft Basin Restoration Plan for the Russian River (2002) lists priorities for restoration based on stream inventory data. Streams that can support coho salmon are given first priority in this plan. Much of the watershed is privately owned, and restoration efforts depend on local landowner cooperation.

Gravel and streamflow conditions suitable for salmonid spawning are prevalent in the Russian River mainstem and tributaries (Winzler and Kelly 1978). In the lower and middle mainstem (below Cloverdale) and the lower reaches of tributaries, loss of riparian vegetation and changes in stream morphology have reduced much of the cover. As a result, summer water temperatures exceed 55°F (13°C) by April in some years (Winzler and Kelly 1978), limiting the habitat use in these areas. However, steelhead have been observed utilizing summer habitat as far downstream as Healdsburg (Cook and Manning 2002; Chase et al. 2000, 2001). Results of a flow-habitat study conducted in the fall of 2001 in the mainstem and in Dry Creek are presented in Section 2.5.

The most urbanized portion of the watershed is in Santa Rosa and the Cotati-Rohnert Park areas. These areas contain most of the constructed flood control channels. Natural streams and constructed channels in the Rohnert Park area are generally low-gradient and run through a valley plain from the foothills to the east. Poor summer water quality and low summer flows limit rearing habitat in this region. Stream surveys conducted by the CDFG and by SCWA indicate that approximately 45 to 60 percent of the Laguna de Santa Rosa watershed may be characterized as moderately degraded, and about 25 percent as severely degraded (S. White, SCWA, pers. comm. 2002). However, the Laguna de Santa Rosa has important wetland and flood control functions for this part of the watershed. Santa Rosa Creek drains to the Laguna de Santa Rosa, which, in turn, drains to Mark West Creek. The upper portion of the Mark West Creek watershed, including the Santa Rosa Creek watershed, contains good steelhead rearing and spawning habitat. Much attention has been given in recent years to restoration opportunities in this area.

The western side of the Russian River valley is cooler, subject to coastal fog in the summer, and supports coniferous forest. Primary coho salmon spawning and rearing habitat occurs in tributaries in this region. Good quality coho salmon habitat also occurs in the upper portion of the Russian River watershed. In addition, parts of the Mark West and Maacama Creek watersheds contain good coho salmon rearing and spawning habitat.

The mainstem above Cloverdale and upper reaches of the tributaries provide the most suitable rearing habitat for steelhead. These areas generally have excellent cover, adequate food supply, and suitable water temperatures for fry and juvenile rearing.

Historic spawning distribution of Chinook salmon in the Russian River watershed has not been documented. Suitable habitat exists in the upper mainstem and in low-gradient tributaries, including Dry Creek. A Chinook salmon redd survey was conducted in the mainstem in 2002 (see Section 2.2.3).

2.1.6.1 Lake Mendocino

Lake Mendocino's nearshore region is very important for sustaining non-native warmwater fisheries, because spawning and juvenile rearing of most of these fish occurs in this area. Some of these fish are potential predators of salmon and trout and may seed downstream habitat when the reservoir spills or releases are made. Aquatic and terrestrial plants inundated by rising water in the winter serve as spawning and rearing habitat. These areas are affected by drawdowns due to water supply releases. When the lake levels are low, CDFG biologists have historically placed dead brush along the nearshore region for cover. The brush cover is flooded during the spring and probably provides the most important spawning and rearing habitat in the reservoir. Lake Mendocino does not provide habitat for native anadromous salmonids because the dam is not passable. "Resident" trout may be present upstream of the lake and may seed downstream habitat if Lake Mendocino spills.

2.1.6.2 Lake Sonoma

Historically, the basin flooded by Lake Sonoma was heavily forested with a combination of riparian woodland, oak woodland, and redwood-Douglas fir forest. When inundation occurred, this vegetation was left intact wherever possible to provide nearshore spawning and rearing habitat for the warmwater species. The nearshore region of the reservoir provides the primary habitat for non-native warmwater species for spawning and juvenile rearing. Some of these species are potential predators of salmon and trout and may seed downstream habitat when spills or releases occur.

Lake Sonoma's water levels currently experience large and rapid fluctuations of 5 to 10 feet per month. These fluctuations are the result of runoff collected in the lake, and reservoir releases made for water supply and flood control operations. Because Lake Sonoma has a steeply sloped bottom, the area of shallow water habitat, which is less than 15 feet, decreases as the reservoir level decreases (SCWA 1996). Because spawning and rearing of most warmwater fish occur near shore, large changes in reservoir levels during spring and summer negatively affect these fish.

2.1.7 Water Quality

Water temperature is a key water quality factor that affects salmonid habitat. Activities within the basin also have the potential to affect DO. Sediment loads within the river may affect turbidity, which can affect the feeding ability of salmonids. These important water quality parameters are discussed below.

2.1.7.1 Water Temperature

Water temperature is one of the most important factors controlling production and distribution of fish in streams. Water temperature directly affects an organism's ability to survive, grow, and reproduce. Within a species-specific tolerance range, as water temperature increases, an organism’s growth rate and physiological performance (e.g., swimming ability) increases. Water temperatures above this tolerance range result in both a reduction in growth and in overall physiological performance, and an increased susceptibility to disease. Ultimately, excessively high temperatures can result in direct mortality. Factors such as DO levels and food availability affect temperature tolerance of salmonids. However, given adequate food transport and suitable habitat, steelhead may grow well in temperatures that are higher than the optimal temperatures reported in literature, which are generally based on northern stocks (Smith and Li 1982). Optimal and lethal water temperature tolerances vary by species and by life stage (e.g., salmonid embryos are less tolerant of high temperatures than juveniles).

There are no site-specific temperature tolerance data on the effects of temperature on coho salmon, steelhead, and Chinook salmon in the Russian River. Stream temperatures that restrict salmonids vary with species and apparently by geographical region. Critical temperatures that limit production and survival of coho salmon, steelhead, and Chinook salmon vary widely in the literature.

RWQCB is reviewing and revising the water quality objective for temperature in the Russian River basin to protect aquatic life, including listed species in the Russian River. This process includes an in-depth analysis of salmonid water temperature tolerances. RWQCB’s recommended standards are currently in draft form (RWQCB 2000). Water temperature criteria for coho salmon, steelhead, and Chinook salmon are presented in Section 4.

Little is known about water temperatures in the Russian River before the arrival of non-indigenous people. Warm-season water temperatures have likely been reduced in reaches below Lake Mendocino and Lake Sonoma due to coldwater releases from these reservoirs. During summer, water temperatures in the Russian River and Dry Creek generally increase with further distance downstream from reservoirs; temperatures in the lower sections of both streams are generally 10°F to 20°F (6^{o}C to 11^{o}C) warmer than in the upper sections (Winzler and Kelly 1978, Prolysts and Beak Consulting 1984).

Lake Mendocino is usually thermally stratified between March and September. During the months that thermal stratification occurs, water temperatures in the bottom layers of the reservoir are much cooler than in surface layers, because they represent water stored during spring runoff that was insulated from warming by the epilimnion. (The epilimnion is the upper layer of a stratified lake that is warmer and consequently less dense so that it floats over a denser, cooler water layer beneath.) The epilimnion is warmed by the sun and becomes too warm for salmonids during the summer. Releases from Lake Mendocino are made from the bottom layer of the lake (hypolimnion) and are cool as long as thermal gradients are present. However, by the end of the summer when the cold-water pool may be drawn down, water temperatures may be warmer. During June, water temperatures below Lake Mendocino average 55°F (12.8°C). By September, the release water is slightly warmer than the water upriver.

During late spring and early summer, water temperatures in the uppermost portion of the river, and its tributaries, are optimal for salmonids. According to a report prepared by CDFG in 1969, coho salmon, steelhead, and Chinook salmon were reported to use a total of 448.5, 132.0 and 101.5 miles, respectively, of the 682.0 miles of tributary streams available (CDFG 1969).

During late summer, temperatures become stressful along portions of the mainstem river. Water temperatures increase in a downstream direction. Summer temperatures in most of the Russian River and in many of its tributaries exceed published optimal ranges for salmon and steelhead, particularly during daytime, and may reach lethal levels under certain hydrologic and meteorological conditions (Winzler and Kelly 1978, PG&E 1979).

Lake Sonoma is thermally stratified during summer months. The epilimnion becomes too warm for salmonid species. A warmwater fishery was established in the reservoir for recreational anglers. The temperature of water released from Lake Sonoma, which is controlled by drawing water from different lake depths, rarely exceeds 60°F (15.6°C). This is likely substantially colder than the pre-impoundment water temperature and produces about a 4°F decrease in summer temperatures in the Russian River below the Dry Creek confluence (RWQCB 1993, USACE unpublished 1999b). Because release water can be drawn from multiple depths in the lake, the cold-water layer in the lake is not as likely to be depleted by the end of the summer as it is in Lake Mendocino.

In 1995, SCWA funded development of a water temperature model encompassing Lake Sonoma, Dry Creek below WSD, and the Russian River below CVD (Resource Management Associates [RMA] 1995). Results of the model under current flow conditions are presented in Section 2.5.

Summer temperatures in many of the Russian River tributaries exceed the optimum temperature ranges for salmon and steelhead. Temperature recorders placed in Santa Rosa and Mark West creeks indicate that summer temperatures in these streams are suitable for salmonids during the summer, except in the more downstream reaches (SCWA 1997-1998, 1998, 1999). Other tributaries, such as Big Sulphur Creek, also have summer water temperatures that are too warm for salmonids in their lower reaches (PG&E 1975). However, in most of the rest of the watershed throughout the summer, these tributaries maintain suitable temperatures for salmonids.

2.1.7.2 Dissolved Oxygen

Growth rates, embryonic development, and fish activity can be limited by a reduction of dissolved oxygen (DO). DO levels vary according to temperature, elevation, the presence of aquatic plants or other aquatic species, and turbulence in the water. DO levels are especially important during egg incubation. Embryos require relatively high oxygen concentrations for successful development. Salmonid species require DO levels between 7 to 9 milligrams per liter (mg/l). During the 1977 drought, DO in the lower Russian

River dropped as low as 5.4 mg/l, but recorded levels have otherwise remained above 7 mg/l (SCWA 1980).

The hypolimnion (deep-water layer) of Lake Mendocino contains little or no DO during summer, so the water released into the river from deep-water intakes has little DO. However, oxygen is replenished within a few hundred yards of the dam by turbulent mixing (SCWA 1980).

The City of Ukiah operated a liquid oxygen injection ring at the CVD outlet to maintain DO in release water at or above 7 mg/l, at 7.5 mg/l at least 90 percent of the time, and at a monthly median of 10 mg/l for the year. In 1997 the City of Ukiah discontinued oxygen injection after monitoring showed the system was ineffective and minimum oxygen requirements could be maintained from turbulence in the bypass valves in the piping system. Water released from Lake Sonoma passes over a flip bucket at the outlet works, while water diverted to and through the fish hatchery passes through a series of aeration ponds prior to release into Dry Creek. These measures maintain DO at suitable levels.

2.1.7.3 Turbidity

Turbidity is caused by fine particulate materials, both inorganic and organic, suspended in water. Scattering and reflection of light by these particles reduce penetration of light, resulting in reductions of primary production and visibility. Reduced primary production may affect DO levels and diminish food and cover for fish and aquatic macroinvertebrates (Lloyd 1987). The Russian River and its tributaries are typically more turbid during winter and spring when runoff is highest. Erosion rates have likely been influenced by activities such as timber harvest practices, agricultural development, grazing by livestock, removal of riparian vegetation for flood control, streamside gravel mining, urban development, and road construction.

Turbidity in the mainstem Russian River above Dry Creek increases in response to releases of highly turbid water from Lake Mendocino in the winter- and spring-runoff period (Ritter and Brown 1971).

In some cases, reservoirs trap suspended sediments carried in storm flows, thereby decreasing concentrations of suspended sediments in downstream releases. However, reservoirs produce phytoplankton that elevates turbidities above levels found in in-flowing waters.

Sedimentation is the settling-out of suspended materials from the water. Sedimentation occurs mainly in lakes, reservoirs, and in low-velocity areas of stream channels. Sedimentation can reduce gravel quality and the success of salmon and steelhead spawning, egg incubation, newly emerged salmonids (fry), and insect survival. Female salmon and steelhead, while digging redds (nests) in the gravel, will release fine sediments into the water column where the higher water velocities will carry the sediments downstream. However, when high levels of silt settle on a redd after spawning, eggs can “smother” and die from lack of oxygen. Dead eggs can promote the growth of fungus, which may spread throughout the entire redd.

High winter flows can flush sand and fine sediments from gravel. However, CVD and WSD have generally reduced the frequency and duration of winter peak flows. Effects of flood control operations are discussed in Section 2.4.2.

2.1.8 Factors Affecting Species Environment (Non-Project)

Factors related to project facilities and operations are summarized in subsequent sections. Non-project factors that affect the species environment in the Russian River basin are summarized here.

- The PVP diverts water from the Eel River to Lake Mendocino. Water released from Lake Mendocino provides augmented base flows in the Russian River in the summer.
- A number of barriers to fish migration exist throughout the watershed. These include natural barriers, permanent and seasonal dams, road crossings and culverts, and thermal barriers.
- Local land uses, including urban development, wastewater discharges, gravel mining, timber harvest, and agriculture affect listed fish species and their habitat.
- The North Coast RWQCB has listed the Russian River in the California 303(d) list as impaired for sediment/siltation.

2.2 Biological Resources

The following sections describe the Russian River fish community and the life histories and migratory behaviors of coho salmon, steelhead, and Chinook salmon in the Russian River. Information is presented on the distribution and abundance of listed fish species as well as on the genetic variance within and between populations.

To assess the effects of baseline activities and provide data for evaluation in this BA, SCWA instituted a series of studies on the biology of the listed species and on project operations under baseline conditions. Pilot studies were also conducted to assess potential modifications to baseline activities. The data resulting from these studies are presented throughout this document to characterize and evaluate baseline project activities.

2.2.1 Russian River Fish Community

The Russian River and its Estuary support a community of fish species that includes both resident and anadromous species, as well as native and introduced species (Table 2-3). To date, 29 species, including 16 native species, have been collected or observed during SCWA monitoring activities in the lower Russian River during the 1999 and 2000 sampling seasons. Three species not documented during SCWA monitoring activities have been historically reported and recorded in the Russian River: white sturgeon, green sturgeon, and pink salmon. Historically, white and green sturgeon occasionally entered the Russian River, although these species apparently did not spawn or rear their young in the river. Stray pink salmon may occasionally be seen but are not reproducers here

Table 2-3 Fishes of the Russian River Watershed

Family	Scientific Name	Common Name	Status
Acipenseridae	*Acipenser transmontanus*	white sturgeon	Native
	Acipenser medirostris	green sturgeon	Native
Catostomidae	*Catostomus occidentalis*	Sacramento sucker *	Native
Centrarchidae	*Lepomis macrochirus*	bluegill *	Introduced
	Lepomis cyanellus	green sunfish *	Introduced
	Pomoxis annularis	white crappie *	Introduced
	Micropterus dolomuieu	smallmouth bass *	Introduced
	Micropterus salmoides	largemouth bass *	Introduced
Clupeidae	*Alosa sapidissima*	American shad *	Introduced
Cottidae	*Cottus asper*	prickly sculpin *	Native
	Cottus gulosus	riffle sculpin *	Native
Cyprinidae	*Lavinia symmetricus*	California roach *	Native
	Mylopharodon conocephalus	hardhead *	Native
	Orthodon microlepidotus	California blackfish *	Native/introduced?
	Lavinia exilicauda	hitch *	Native
	Ptychocheilus grandis	pikeminnow *	Native
	Pimephales promelas	fathead minnow *	Introduced
	Notemigonus crysoleucas	golden shiner *	Introduced
	Cyprinus carpio	carp *	Introduced
Embiotocidae	*Hysterocarpus traski*	Russian River tuleperch *	Native
Gasterosteidae	*Gasterosteus aculeatus*	threespine stickleback *	Native
Ictaluridae	*Ameiurus catus*	white catfish *	Introduced
	Ameiurus spp.	bullhead *	Introduced
Percichthyidae	*Morone saxitalis*	striped bass *	Introduced
Petromyzontidae	*Lampetra tridentata*	Pacific lamprey *	Native
	Lampetra richardsoni	western brook lamprey **	Native
		river lamprey***	
Poecillidae	*Gambusia affinis*	mosquitofish *	Introduced
Salmonidae	*Oncorhynchus tshawytscha*	Chinook salmon *	Native
	Oncorhynchus keta	chum salmon *	Native/Stray
	Oncorhynchus mykiss	steelhead *	Native
	Oncorhynchus kisutch	coho salmon *	Native
	Oncorhynchus gorbuscha	pink salmon	Native/Stray?

*Observed during SCWA monitoring activities in the Russian River during the 1999 and 2000 sampling seasons.

**Observed during SCWA monitoring activities in the Russian River during 2002 sampling season.

***Caught by Merritt Smith Consulting.

Sources: Cook 2003a; Cook et al. 2002; Chase et al. 2001; Chase et al. 2000; Hopkirk 1980.

(Hopkirk 1980). Abundant resident species inhabiting the mainstem Russian River include smallmouth bass, Sacramento sucker, hardhead, tuleperch, and California roach (Chase et al. 2000, 2001, 2002, Cook 2003a).

Streams typically exhibit a gradation in habitat types longitudinally as they flow from their headwaters downstream (Moyle and Nichols 1973). Fish populations change in response to habitat conditions. Two important factors affecting the distribution of fish are water temperature and stream gradient. Changes in the watershed that affect water temperature (primarily alterations to the riparian habitat) influence the longitudinal position where the thermal regime becomes unsuitable for salmonids. Moyle and Nichols (1973; Moyle 1976, 2002) described four freshwater fish zones and a fifth estuarine zone for the Sacramento-San Joaquin river systems. The five zones are the Rainbow Trout Zone, the California Roach Zone, the Squawfish (pikeminnow)-Sucker-Hardhead Zone, the Deep-bodied Fish Zone, and the Estuarine Zone. The borders between fish zones are not distinct, but gradually shift from one zone to another in response to changes in habitat.

Sampling conducted in tributaries to the Russian River (Santa Rosa, Millington, and Mark West creeks) between 1999 and 2001 as part of SCWA's Population Monitoring Pilot Study (Chase and Benkert 2003) (described in Section 2.2.4) indicates that the fish community in the Russian River basin forms analogous aggregations to those described by Moyle and Nichols (1973; Moyle 1976, 2002). In general, species composition in the larger creeks is dominated by steelhead and sculpin in the upper reaches, with California roach becoming important in the middle reaches (SCWA 2002). In lowland tributary channels, California roach, sculpin, and Sacramento sucker are the dominant species (SCWA 2002). Moyle (1976) describes the Rainbow Trout Zone as headwater streams with relatively high gradients, and cold (seldom greater than 21°C), well-oxygenated water. Fish communities in this zone are dominated by rainbow trout, although sculpin are often found in the lower portions of the zone. Upper Mark West and Santa Rosa creeks are analogous to the Rainbow Trout Zone. The California Roach Zone is typified by warm, intermittent streams. California roach is the dominant species in the middle section of Mark West Creek and below Highway 12 on Santa Rosa Creek. The Squawfish (pikeminnow)-Sucker-Hardhead Zone is found in the mainstem Russian River (Chase et al. 2001), but riffles in the upper reach have been observed to be dominated by rearing steelhead with few, if any, pikeminnow, suckers, or hardhead (SCWA 2002, unpublished data).

Abundant species in the Estuary include threespine stickleback, topsmelt, prickly sculpin, starry flounder, and staghorn sculpin (SCWA 2001b; J. Roth, pers. comm., as cited in RMI 1997). Other species observed during monitoring activities (including otter trawl and beach seine sampling) at the Estuary are listed in Table 2-4 (SCWA 2001b).

Table 2-4 Fish Species Observed in the Russian River Estuary, 1992 to 2000

Family	Scientific Name	Common Name	Status
Atherinidae	*Atherinops affinis*	topsmelt	Native
Bothidae	*Citharichthys sordidus*	Pacific sanddab	Native
	Citharichthys stigmaeus	speckled sanddab	Native
Catostomidae	*Catostomus occidentalis*	Sacramento sucker	Native
Centrarchidae	*Lepomis cyanellus*	green sunfish	Introduced
	Lepomis macrochirus	bluegill	Introduced
	Micropterus dolomieui	smallmouth bass	Introduced
Clupeidae	*Clupea harengus pallasii*	Pacific herring	Native
Cottidae	*Artedius lateralis*	smoothhead sculpin	Native
	Artedius notospilotus	bonyhead sculpin	Native
	Cottus asper	prickly sculpin	Native
	Enophrys bison	buffalo sculpin	Native
	Enophrys taurina	bull sculpin	Native
	Leptocottus armatus	staghorn sculpin	Native
	Scorpaenichthys marmoratus	cabezon	Native
	Sebastes paucispinis	bocaccio	Native
	Sebastes melanops	black rockfish	Native
Cyprinidae	*Cyprinus carpio*	carp	Introduced
	Lavinia symmetricus navarroensis	Navarro roach	Native
	Mylopharodon conocephalus	hardhead	Native
	Ptychocheilus grandis	Sacramento pikeminnow	Native
Embiotocidae	*Cymatogaster aggregata*	shiner surfperch	Native
	Hyperprosopon anale	spotfin surfperch	Native
	Hyperprosopon argenteum	walleye surfperch	Native
	Hyperprosopon ellipticum	silver surfperch	Native
	Hysterocarpus traskii	Russian River tuleperch	Native
Engraulididae	*Engraulis mordax*	northern anchovy	Native
Gadidae	*Gadus macrocephalus*	Pacific tomcod	Native
Gasterosteidae	*Gasterosteus aculeatus*	threespine stickleback	Native
	Aulorhynchus flavidus	tube-snout	Native
Gobiesocidae	*Gobiesox maendricus*	northern clingfish	Native
Gobiidae	*Clevelandia ios*	arrow goby	Native
Hexagrammidae	*Hexagrammos decagrammus*	kelp greenling	Native
	Ophiodon elongatus	lingcod	Native
Osmeridae	*Hypomesus pretiosus*	surf smelt	Native
	Spirinchus thaleichthys	longfin smelt	Native
Pleuronectidae	*Isopsetta ischyra*	hybrid sole	Native
	Parophrys vetulus	English sole	Native
	Platichthys stellatus	starry flounder	Native
	Psettichthys melanostictus	sand sole	Native
Pholididae	*Pholis ornata*	saddleback gunnel	Native
	Apodichthys flavidus	penpoint gunnel	Native
Poecillidae	*Gambusia affinis*	mosquitofish	Introduced
Salmonidae	*Oncorhynchus mykiss*	steelhead	Native
	Oncorhynchus tshawytscha	Chinook salmon	Native
Sciaenidae	*Genyonemus lineatus*	white croaker	Native
Syngnathidae	*Syngnathus griseolineatus*	bay pipefish	Native

Source: SCWA 2001b.

2.2.2 Life Histories and Migratory Behaviors of Coho Salmon, Steelhead, and Chinook Salmon

Coho salmon, steelhead, and Chinook salmon are anadromous species (although steelhead may also exhibit a life-history type that spends its entire life cycle in freshwater). These species migrate upstream from the ocean as adults and spawn in gravel substrate. Their eggs incubate for a short period, depending on water temperature, and generally hatch in the winter and spring. Juveniles spend varying amounts of time rearing in the streams and then migrate out to the ocean.

2.2.2.1 Coho Salmon

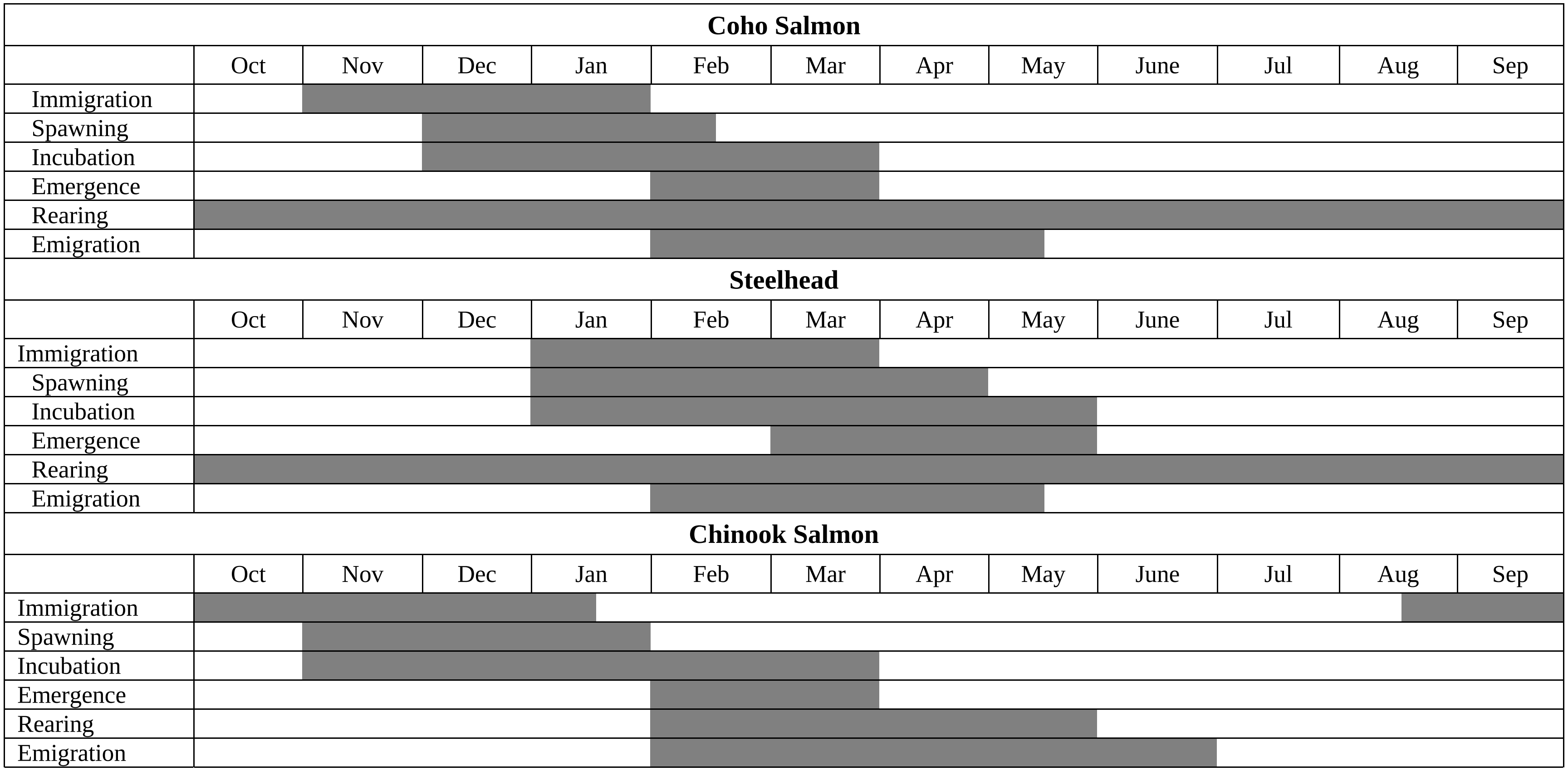
The coho salmon life history is quite rigid, with a relatively fixed three-year life cycle. The best available information suggests that life-history stages occur during times shown in Figure 2-2 (Hopkirk and Northern 1980; Moyle 1976; Moyle et al. 1989; Steiner Environmental Consulting 1996; S. White, SCWA, pers. comm. 1999-2001). Most coho salmon enter the Russian River in November and December and spawn in December and January. Spawning and rearing occur in tributaries to the lower Russian River. The most upstream tributaries with coho salmon populations include Forsythe, Mariposa, Rocky, Fisher, and Corral creeks. The mainstem below Cloverdale serves primarily as a passage corridor between the ocean and the tributary habitat.

After hatching, young coho salmon spend about one year in fresh water before they become smolts (undergo a physiological change for adaptation to seawater) and migrate to the ocean. Freshwater habitat requirements for coho salmon rearing include adequate cover, food supply, and suitable water temperatures. Primary habitat for coho salmon includes pools with extensive cover. Outmigration takes place in late winter and spring. Coho salmon live in the ocean for about a year and a half, return as three-year-olds to spawn, and then die. The factors most limiting to juvenile coho salmon production are not completely understood, but may include high water temperatures, poor summer and winter habitat quality, and predation.

2.2.2.2 Steelhead

Adult steelhead generally begin returning to the Russian River with the first heavy rains of the season in November or December, and continue to migrate upstream into March or April. Adults have been observed in the Russian River during all months (S. White, SCWA, pers. comm. 1999). However, the peak migration period tends to be January through March (Figure 2-2).

Flow conditions are suitable for upstream migration in most of the Russian River and larger tributaries during the majority of the spawning period in most years. Sandbars blocking the river mouth in some years may delay entry into the river. However, when the sandbar is closed, the flow may be too low and water temperature too high to provide suitable conditions for migrating adults farther up the river (CDFG 1991).



References: Hopkirk (1980); Moyle (1976); Moyle et al. (1989); Steiner Environmental Consulting (1996); S. White, SCWA, pers. comm. 1999-2001.

Primary period of activity.

Figure 2-2 Phenology of Coho Salmon, Steelhead, and Chinook Salmon

Most steelhead spawning takes place from January through April, depending on the time of freshwater entry (Figure 2-2). Steelhead spawn and rear in tributaries from Jenner Creek near the mouth, to upper basin streams, including Forsythe, Mariposa, Rocky, Fisher, and Corral creeks. Low numbers of juvenile wild and hatchery steelhead have been observed in the Russian River near Wohler Pool during the first three years of sampling results for SCWA's inflatable dam/Wohler Pool Fish Sampling Program, but more substantial numbers were documented in 2002. Snorkel surveys in sites throughout the mainstem in the summer and fall of 2002 documented more substantial steelhead numbers, mostly above Cloverdale but also as far downstream as Healdsburg (Cook 2003b).

Distribution of steelhead was correlated with water temperatures (Cook 2003b). The highest temperatures occurred in the Alexander Valley and Healdsburg reaches (25ºC and 24ºC, respectively). Although maximum temperatures were as high as 22ºC and 22.5ºC in the Ukiah and Canyon reaches, respectively, steelhead observed in these reaches during diver surveys appeared healthy and vigorous. Based on these observations, it appears that steelhead may rear in suitable habitat within the mainstem Russian River through the summer.

After hatching, steelhead spend one to two years in fresh water. Fry and juvenile steelhead are extremely adaptable in their habitat selection. Requirements for steelhead rearing include adequate cover, food supply, and suitable water temperatures. The mainstem above Cloverdale and upper reaches of the tributaries provide the most suitable habitat; generally, these areas have excellent cover, adequate food supply, and suitable water temperatures for fry and juvenile rearing. The lower reaches of some tributaries provide less cover; the streams are often wide and shallow and have little riparian vegetation, and water temperatures are often too warm to support steelhead. In the summer, these areas can completely dry up. Available cover has been reduced in much of the mainstem and in many tributaries due to loss of riparian vegetation and changes in stream morphology.

Emigration usually occurs between February and June, depending on flow and water temperatures. Steelhead smolts emigrate through the Wohler Pool at an average size of approximately 175 millimeter (mm) fork length (FL) (range 83 mm to 250 mm) (Chase et al. 2001). Sufficient flow is required to cue smolt downstream migration. Excessively high water temperatures in late spring may inhibit smoltification in late migrants.

2.2.2.3 Chinook Salmon

Adult Chinook salmon begin returning to the Russian River as early as August, but most upstream migration occurs in October and November (Chase et al. 2001, 2002). Chinook salmon may continue to enter the river through December and spawn into January (Figure 2-2). Adult Chinook salmon migrate upstream to their spawning habitat, located primarily in the mainstem Russian River above Asti and in selected tributaries such as Dry Creek.

Unlike coho salmon and steelhead, the young Chinook salmon begin their outmigration soon after emerging from the gravel. Freshwater residence in coastal California stocks, including outmigration, usually ranges from two to four months. Juvenile Chinook salmon in the Russian River emigrate as fingerlings from late February through June. Chinook salmon in the Russian River emigrate through the Wohler Pool at about 90 mm FL (with a range 54 to 140 mm) (Chase et al. 2001, 2002).

Ocean residence can be from one to seven years, but most Chinook salmon return to the Russian River as two- to four-year-old adults. Like coho salmon, Chinook salmon die soon after spawning.

2.2.3 Species Range and Abundance

Data describing the historic range of coho salmon, steelhead, and Chinook salmon in the Russian River basin are limited. However, CDFG has compiled and reviewed salmonid presence data collected between 1920 and 2000 for streams in the Russian River watershed. Figure 2-3 is a CDFG map of the Russian River basin, showing salmonid distribution by species based on presence data from 1920 to 2000.

Salmonids, including coho salmon, steelhead, and Chinook salmon on the west coast of the United States, have declined in abundance in the past several decades. For salmonid populations in California coast ESUs, the present depressed condition is the result of several long-standing, human-induced factors (e.g., habitat degradation, timber harvest, water diversions, and artificial propagation) that exacerbate the adverse effects of natural environmental variability from such factors as drought and poor ocean conditions. NOAA Fisheries has prepared several documents that address the factors that have led to the decline of coho salmon, steelhead, and Chinook salmon (NMFS 1995, 1996a, 1996b, 1998a, 1998b). These reports generally conclude that all of the factors identified in Section 4(a)(1) of the ESA have played a role in the decline of coho salmon, steelhead, and Chinook salmon. The destruction and modification of habitat, overutilization for recreational and/or commercial purposes, and natural and human-made factors are identified in these reports as the primary reasons for the decline of these west coast salmonids.

SCWA monitored the entire Chinook salmon run for the first time in 2000 at the Mirabel inflatable dam, and estimated a run of 1,500 Chinook salmon in 2000 and at least that many in 2001 (Chase et al. 2001, 2002). A total of 5,466 Chinook salmon adults were observed in 2002 (Chase et al. 2003).

There are no recent population estimates for coho salmon or steelhead in the Russian River. Population estimates for steelhead (1,750 to 7,000 adults) have been widely cited from McEwan and Jackson 1996, who attribute these estimates to CDFG. Conversations between Bill Cox and SCWA staff indicate that these estimates were based on professional judgment, and not on specific sampling data, studies, or research (S. White, SCWA, pers. comm. 1996).

Data describing the historic abundance of coho salmon, steelhead, and Chinook salmon in the Russian River watershed are scarce. Investigations into historic estimates of abundance reveal that there have not been any accurate fish counts or population estimates conducted for coho salmon, steelhead, or Chinook salmon in the Russian River basin. Early estimates were based largely on inconsistent angler catch data and newspaper accounts. For example, estimates of steelhead population numbers cited as CDFG 1965 in NMFS' *Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California* (NMFS 1996a), were based on estimates by Hinton (1963), who extrapolated on estimates from Evans 1959. Hinton's methodology is described in Prolysts and Beak (1984) as follows:

> *"Hinton (1963) expanded estimates of adult steelhead runs in three tributaries (East Branch Russian River, Dry Creek, and Santa Rosa Creek) to the total Russian River on the basis of proportionate stream mileage and drainage area. He estimated the annual Russian River run at 50,000 fish. The above estimate of 2,000 fish at the base of the Coyote Dam [2,000 was estimated by Evans (1959) based on the rescue of 379 fish at the base of the dam] was used for the East Branch. Estimates for Dry Creek and Santa Rosa Creek were based on brief field visits made in connection with proposed developments."*

The history of the derivation of steelhead population data, described above, exemplifies the lack of reliable, high-quality population data for salmonids in the Russian River basin. Table 2-5 summarizes the presence of listed salmonid species in recent years.

2.2.3.1 Coho Salmon

Coho salmon are generally considered to be less widespread and less abundant than Chinook salmon or steelhead in the Russian River basin. Coho salmon spawn and rear in tributaries to the Russian River. Emigrating smolts and adults migrating upstream use the mainstem Russian River primarily for migration to and from spawning and nursery areas in the tributaries. There are no data indicating that coho salmon spawn or rear in the mainstem.

Historic distribution of coho salmon included numerous tributaries in the lower and upper Russian River, as far north as Corral Creek. Presence-absence data for coho salmon presented in the status review update (NMFS 1998b) and CDFG surveys (unpublished data), identify streams within the entire Russian River basin for which coho salmon presence has been noted since 1989 (Table 2-6). Data have been prioritized to indicate streams for which: 1) the most recent survey recorded coho salmon presence; 2) the most recent survey recorded coho salmon absence but which had an equal or greater number of surveys noting coho salmon presence; 3) the most recent and the majority of surveys recorded coho salmon absence.

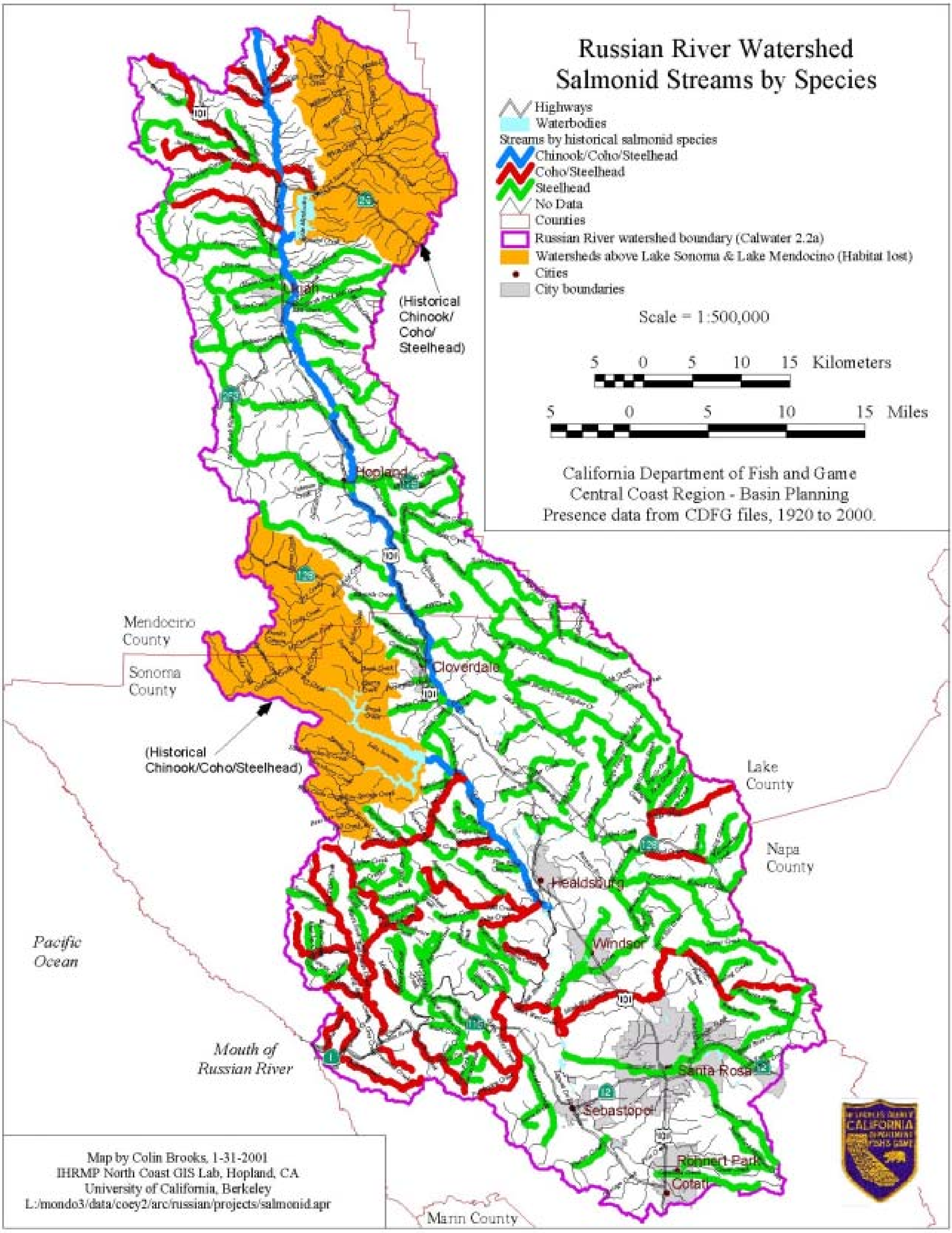


Figure 2-3 CDFG's Map of Salmonid Distribution in the Russian River Basin

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Table 2-5 Presence of Listed Salmonid Species in Russian River and Tributaries

Stream Name	Coho Salmon Present[1, 2]	Steelhead Present[2, 3]	Chinook Salmon Present	Stream Name	Coho Salmon Present[1, 2]	Steelhead Present[2, 3]	Chinook Salmon Present
Alder (Mendo Co.)		X		Duncan	X	X	
Angel		X		Dutch Bill		X	
Baker's		X		Dutcher		X	
Bear		X		Duvoul		X	
Bear Canyon		X		East Austin		X	
Bearpen		X		East Fork Russian River		X	X
Bidwell		X		Eldridge		X	
Big Austin		X		Fall		X	
Big Sulphur		X	X	Felta	X	X	
Black Rock		X		Feliz			X
Blue Gum		X		Fisher	X	X	
Blue Jay		X		Forsythe	X	X	X
Blue Line		X		Franz		X	
Briggs		X		Freezeout	X	X	
Chapman Branch		X		Gibson		X	
Conshea		X		Gill		X	
Coon		X		Gill South Fork		X	
Corral	X	X		Gilliam		X	
Crane		X		Gird		X	
Crocker		X		Grape		X	
Devil		X		Gray		X	
Doolin		X		Green Valley	X	X	
Dry		X	X	Griffen (Un-named)		X	

Table 2-5 Presence of Listed Salmonid Species in Russian River and Tributaries (Continued)

Stream Name	Coho Salmon Present[1, 2]	Steelhead Present[2, 3]	Chinook Salmon Present	Stream Name	Coho Salmon Present[1, 2]	Steelhead Present[2, 3]	Chinook Salmon Present
Grub		X		McClure		X	
Hale		X		McDonnell		X	
Harrison		X		McDowell		X	
Hobson		X		Mercer (Un-named)		X	
Howell		X		Mill	X	X	
Hulbert		X		North Fork Mill		X	
Ingalls		X		Millington		X	
Jack Smith		X		Miller		X	
Jenner Gulch		X		Mission		X	
Johnson		X		Morrison		X	
Jonive		X		Olema		X	
Kidd		X		Orrs		X	
Laguna de Santa Rosa	X			Palmer		X	
Lancel		X		Parsons		X	
Lancel North Fork		X		Pechaco		X	
Little Briggs		X		Pena		X	
Little Sulphur		X		Peterson		X	
Lovers Gulch		X		Pole Mountain		X	
Maacama	X	X		Porter		X	
Maacama (Upper)		X		Purrington	X	X	
Mariposa	X	X		Redwood	X	X	
Mark West	X	X		Robinson		X	

Table 2-5 Presence of Listed Salmonid Species in Russian River and Tributaries (Continued)

Stream Name	Coho Salmon Present[1, 2]	Steelhead Present[2, 3]	Chinook Salmon Present	Stream Name	Coho Salmon Present[1, 2]	Steelhead Present[2, 3]	Chinook Salmon Present
Martin		X		Rocky	X	X	
Mainstream Russian River	X	X		Squaw		X	
S.B. Robinson		X		Sturgeon		X	
Salt (Un-named)		X		Sulphur		X	
Salt Hollow		X		Thompson		X	
North Fork Salt Hollow		X		Turtle (unnamed tributary)		X	
Santa Rosa	X	X		Tyrone Gulch		X	
Sausal		X		Walker		X	
Seward		X		Wallace		X	
Sexton		X		Ward	X	X	
Sheephouse	X	X		Willow	X	X	
Sheephouse East Fork		X		Wine	X	X	
Sheephouse SW Tributary		X		York		X	
Smith		X					

[1]Presence Data was modified from NMFS 2001 with CDFG unpublished data.
[2]Unpublished California Department of Fish and Game 2001 data from the electrofishing database for the Russian River Watershed (CDFG in preparation).
[3]Merritt Smith Consulting. Salmonid Juvenile Density Monitoring In Sonoma County Streams, Synthesis of a Nine-Year Study (1993-2001).

Table 2-6 Coho Salmon Presence/Absence for Russian River Tributaries since 1990

Stream Name	Present Years[1]	Years None Detected	Survey Priority[2]
Willow Creek	1990, 95	1991, 92, 93, 94, 96, 98, 2000, 01, 02	2
Sheephouse Creek	1996, 1995[3]	1998, 2001	2
Freezeout Creek	1995	1994, 96, 2000, 01, 02	2
Ward Creek	1996	2001, 02	2
Dutch Bill Creek	2002	2001	1
Green Valley Creek	1993, 94, 95, 96, 97, 99, 00, 01, 02	1998	1
Purrington Creek	1994	2001	1
Mark West Creek	1993, 94, 95, 2001	1996, 97, 99, 2002	1
Laguna de Santa Rosa	1994		3
Santa Rosa Creek	1993, 94	1995, 2001	2
Mill Creek	1995	1996, 2001, 02	1
Wine Creek	1998	2001, 02	3
Unnamed (Turtle) [3]	1996	2001, 02	3
Maacama Creek	1993, 94, 95	1996, 97, 99	3
Redwood Creek	1993, 94, 2001	1995, 96, 97, 99, 2002	1

[1]Presence/absence data were modified from NMFS 2001 with CDFG unpublished data.

[2]First-priority streams are those streams for which the last survey recorded the presence of coho salmon at some life-history stage. Second-priority streams are those streams for which historical presence is noted, but more recent surveys did not record presence. Third-priority streams are those streams for which multiple recent surveys have not recorded the presence of coho salmon.

[3]Presence noted in an unnamed tributary.

There have been no recent efforts to quantify coho salmon populations in the Russian River, and a reliable estimate of coho salmon abundance within the basin has never been developed. Criteria used by NMFS (1998b) to evaluate population trends for the coho salmon status review update required a minimum of six years of abundance data for which sample sites and survey methods were consistent over all years. There are no streams within the Russian River basin that have six years of abundance data. Though limited in sample size, coho salmon data collected since 1989 indicate very small numbers of coho salmon exist within relatively isolated pockets of the Russian River. In 2001 and 2002, 32 and 28, respectively, of the historic coho salmon streams within the Russian River were sampled for juvenile coho salmon. Coho salmon were found in only three of these steams in 2001 and two streams in 2002 (CDFG unpublished data). Genetic studies indicate populations in the Russian River basin are highly inbred (Hedgecock et al. 2003).

No coho salmon have been observed during survey efforts conducted between 1999 and 2001 on Mark West, Santa Rosa, and Millington creeks for SCWA's Russian River Basin Steelhead and Coho Salmon Monitoring Program (Pilot Study). However, CDFG reports coho salmon present in Mark West Creek in 2001 (CDFG unpublished data). Green Valley Creek appears to be the only current stronghold for coho salmon.

The DCFH on Dry Creek at WSD produced and released an average of about 70,000 age 1+ coho salmon each year, from 1980 to 1998. However, no coho salmon have been produced at the hatchery since 1998.

2.2.3.2 Steelhead

Steelhead are widespread in the Russian River watershed, and occupy all of the major tributaries and most of the smaller ones (Table 2-5). Historical data show steelhead presence in all of the major tributaries and most of the smaller ones in the Russian River watershed (Figure 2-3). Most spawning and rearing habitat for steelhead is likely to occur in high-gradient habitats present in tributaries. During snorkel surveys conducted by SCWA in 2002, rearing steelhead were observed in the upper mainstem, mostly between Hopland and Cloverdale, but also as far south as Healdsburg (Cook 2003b). Observation of large numbers of young-of-the-year (YOY) steelhead during recent monitoring by SCWA at the Mirabel inflatable dam and Wohler Pool indicate that some spawning and juvenile rearing may occur in the lower and middle mainstem before smolt outmigration (see Section 2.2.4).

There have been no recent efforts to quantify steelhead populations in the Russian River, but there is general agreement that the population has declined in the last 30 years (CDFG 1984, 1991). However, limited quantitative data are available to support this assumption. SCWA, CDFG, and NOAA Fisheries are currently developing programs to monitor trends in salmonid populations for the basin.

There has been substantial planting of hatchery-reared steelhead within the basin, which may have affected the genetic constitution of the remaining natural population. Almost all steelhead planted prior to 1980 were from out-of-basin stocks (Steiner 1996). Since

1982, stocking of hatchery-reared steelhead has been limited to progeny of fish returning to the DCFH and the CVFF.

2.2.3.3 Chinook Salmon

Historic data show Chinook salmon presence in the mainstem of the Russian River, the East Fork Russian River, and in Dry Creek (Figure 2-3). Chinook salmon currently spawn in the mainstem upstream of Asti and in larger tributaries, including Dry Creek (Steiner 1996, B. Coey, CDFG, pers. comm. 2000). Chinook salmon tissue samples were collected in 2000 by SCWA, CDFG, and NOAA Fisheries from the mainstem, Forsythe, Feliz, and Dry creeks. There were anecdotal reports of Chinook salmon in the Big Sulphur system.

It is uncertain whether or not naturally spawning Chinook salmon were historically present in the Russian River (NMFS 1999). There is little information pertaining to Chinook salmon populations prior to the completion of the PVP project in 1922. Snyder (1908) described Chinook salmon in the Russian River. Steiner (1996) reviewed historical reports for records of Chinook salmon. Cannery records from before 1890 suggest that most of the salmon harvested were too small (less than 20 pounds) to be Chinook salmon. Several reports and correspondences (Shapovalov 1946, 1947, and 1955; Murphy 1945 and 1947; Pintler and Johnson 1956; Fry 1979, cited in Steiner 1996) suggest there were few, if any, Chinook salmon in the river. Other reports and communications indicate that Chinook salmon spawned in the upper portions of the river (Lee and Baker 1975), and that Chinook salmon were harvested by local tribes in Coyote Valley prior to construction of CVD (W. Jones, CDFG, pers. comm., cited in Steiner 1996).

Chinook salmon population estimates beginning in the 1960s suggest that in the past, documented returns might have been associated with periods of sustained hatchery stocking. CDFG estimates Chinook salmon escapement in 1966 was 1,000. USACE in 1982 reported an estimated escapement of only 500, despite heavy planting in Dry Creek during the 1980s. Adult returns to DCFH fell short of total escapement goals, although it is unknown what portion of the return was harvested through sport and commercial fishing. The largest adult Chinook salmon return to DCFH was 212 fish, excluding grilse (12 percent of the goal in 1988-89).

Smolt emigration studies and adult counts conducted by SCWA at the Mirabel inflatable dam since 1999 provides the most reliable estimates of Chinook salmon abundance within the basin (Chase et al. 2000, 2001, 2002). The 2002 mark/recapture study estimated over 200,000 Chinook salmon smolts passed the dam from March 27 through June 8 (Chase et al. 2003). These data show that although Chinook salmon have not been stocked in recent years, natural reproduction has occurred. Furthermore, video monitoring of the fish ladders documented substantial numbers of adult Chinook salmon. The smolt emigration studies and monitoring of adult passage are described in Section 2.2.4. Distribution of Chinook salmon redds observed during a 2002 survey of the Russian River is presented in Figure 2-4.

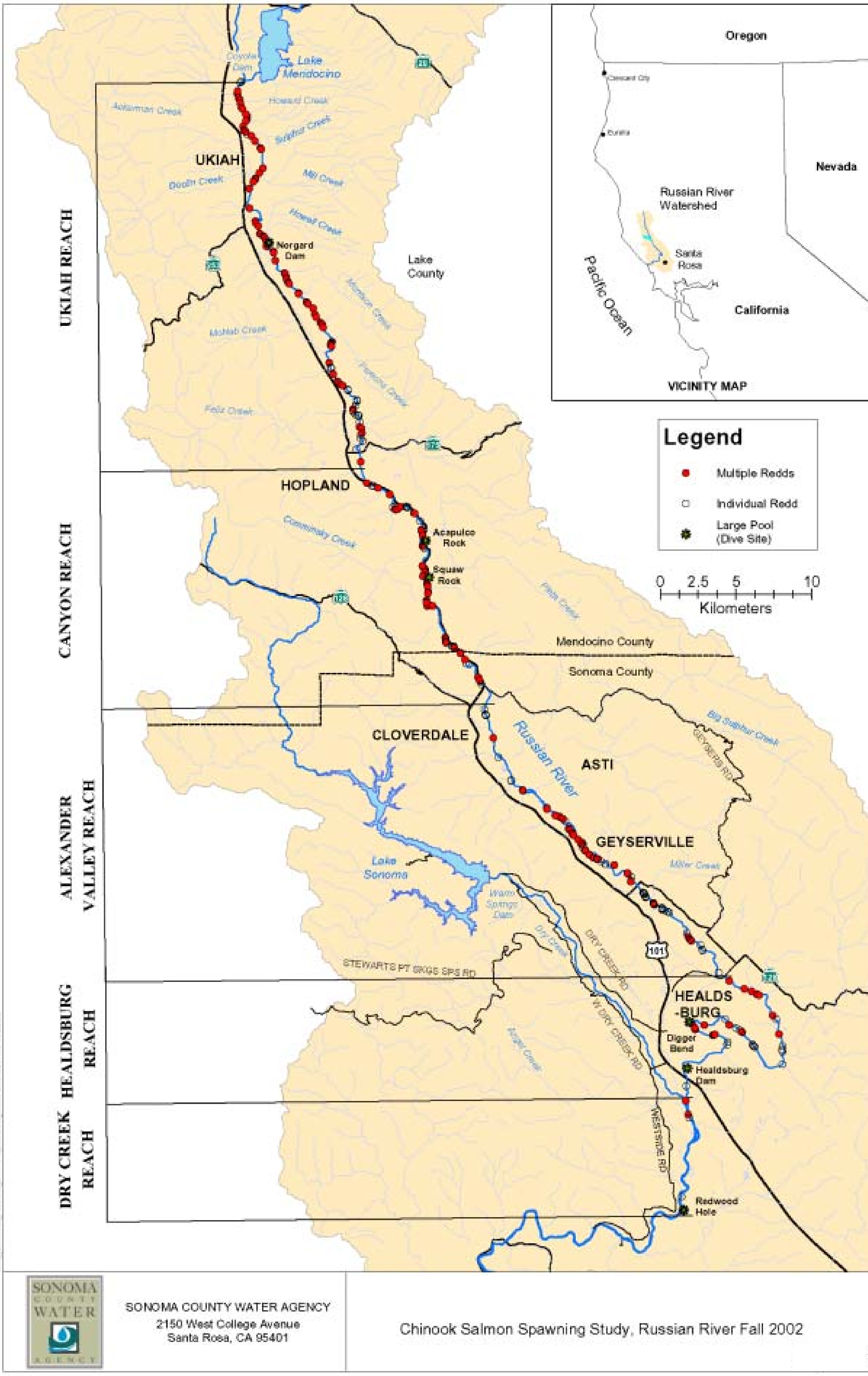

Figure 2-4 Chinook Salmon Spawning Study, Russian River

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2.2.4 Summary of Current Salmonid Distribution and Abundance Studies

SCWA has initiated several studies in recent years to address the need for additional data describing salmonid population trends, distribution, habitat use, and abundance in the Russian River basin. Studies currently in progress include a population monitoring program designed to detect trends in salmonid populations in the basin, and a fish-sampling program designed to assess potential effects to salmonids from SCWA's inflatable dam. Studies were conducted under a Section 10(a)(1)(a) permit, issued to SCWA by NOAA Fisheries. Information from these studies that is specifically relevant to the status of salmonid species in the Russian River is briefly summarized in the following sections. Additional information from these studies is described where relevant in other sections of this BA.

2.2.4.1 SCWA's Population Monitoring Pilot Study – Electrofishing Surveys

SCWA has initiated a population-monitoring program designed to detect trends in salmonid populations and to identify possible fisheries management and enhancement opportunities in the watershed. The program is referred to as the Russian River Basin Steelhead and Coho Salmon Monitoring Program (Pilot Study). It began in fall 1999 with a pilot study to collect detailed information on the distribution, habitat use, and abundance of juvenile coho salmon and steelhead in streams of the Russian River basin (Cook et al. 2002). Streams sampled include Santa Rosa, Millington, and Mark West creeks (tributaries of the Russian River). Santa Rosa and Millington creeks were sampled in 1999; all three creeks were sampled in 2000; and Santa Rosa and Millington creeks were sampled in 2001. In addition, surveys were conducted on Sheephouse Creek in 2000, and Green Valley Creek in 2001. Study methods and results are described in Cook et al. (2002), and are summarized briefly below.

Summary of Study Methods

Fish sampling was conducted along the three study streams within selected reaches. Stream reaches were distinguished by channel type as described by Rosgen (1996). The three channel types sampled in the study included:

B2 Channel: Streams with moderate entrenchment, moderate gradient, and aquatic habitat dominated by riffles and occasional pools.

C4 Channel: Low-gradient, meandering streams dominated by riffle and pool habitats.

F4 Channel: Low-gradient, entrenched streams with a broad bed and dominated by riffle and pool habitats.

Each channel type was divided into subreaches and habitat units for fish sampling purposes. Within each stream reach, habitat data was sorted into three general habitat types: riffle, flatwater, and pool. All study reaches included the three habitat types, except Santa Rosa Creek F4 Channel, which had only flatwater and pool habitat types.

Electrofishing was used to sample fish and consisted of a stratified random sampling method. Fish scales from a sample of captured fish were collected for age analysis.

Habitat data were collected at habitat units, including maximum water depth, length, and average width.

Summary of Results

No coho salmon were observed during the electrofishing surveys, while steelhead were captured in all three study streams and in most sample units. A total of 31,795 fish were captured during the three-year study and 6,835, or 21.5 percent, were steelhead. In general, steelhead was the predominant species in the B2 Channel headwater reaches of the three study streams.

<u>Santa Rosa Creek</u>

Where steelhead were present, the predominant age class was YOY with a few older fish present. In 1999, the age-class composition of steelhead greater than one year old was 0 percent in the F4 Channel, 8 percent in the C4 Channel, and 17 percent in the B2 Channel. Similar age-class trends occurred in 2000 and 2001. All age classes of steelhead were disproportionately found in pool habitats. During the three-year study, 63 percent of the steelhead were captured in pools. One exception was the predominance of steelhead in flatwater habitats in the F4 Channel. This exception is likely due to a small sample size and marginal pool habitat for steelhead. These data indicate that pool habitats of the C4 and B2 channels provide the primary rearing and year-round habitat for steelhead, and the F4 Channel is primarily used for migration.

The population trend from 1999 to 2001 in Santa Rosa Creek varied by habitat type, but in general included a peak in 2000 with relatively lower numbers observed in 1999 and 2001. This trend was likely affected by annual rainfall.

<u>Millington Creek</u>

Millington Creek is a small headwater tributary of Santa Rosa Creek located in Mt. Hood Regional Park. The channel type is an F2b and B2 combination. Steelhead ranged from 78 to 89 percent of the total catch. Species composition along this reach consisted of native steelhead and sculpin. The predominant age class of steelhead was YOY. Steelhead were primarily found in pool habitats followed by flatwater and then riffles. The population trend from 1999 to 2001 in Millington Creek included a peak in 2000 with lower numbers observed in 1999 and 2001.

<u>Mark West Creek</u>

The Mark West Creek study area included an F4 Channel reach above the confluence with Santa Rosa Creek, followed by a lower B2 Channel and C4 Channel located in the foothills, and an upper B2 Channel in the mountainous headwaters. Species composition along this reach varied from several native and non-native warmwater species in the F4 Channel lowlands with less than 1 percent steelhead, to a composition of 100 percent steelhead in the upper B2 Channel headwaters. Where steelhead were present, the predominant age class was YOY, with a few fish older than one year present. Steelhead of all age classes were disproportionately found in pool habitats. Because surveys were conducted during a single year, no population trends could be evaluated.

2.2.4.2 SCWA's Population Monitoring Pilot Study – Snorkeling Surveys

In addition to the electrofishing surveys described above, snorkeling surveys are being conducted as part of the Russian River Basin Steelhead and Coho Salmon Monitoring Program. Presence-absence surveys were conducted on Sheephouse Creek in 2000, and Green Valley Creek in 2001. These creeks were selected for the study based on recent reports of coho salmon occurrences. Snorkeling survey methods and results are described in Cook et al. (2002), and are summarized briefly below. The mainstem Russian River from Healdsburg to Ukiah was surveyed in 2002 (Cook 2003b). Snorkeling survey methods in the mainstem of the Russian River were different; one-half-kilometer (km) reaches were surveyed by teams of three, one on each bank and one in the center, and a certain number of sites per reach of river were surveyed.

Snorkel surveys were conducted in pools with a maximum depth greater than 40 centimeters (cm) and underwater visibility at least 200 cm. On Green Valley Creek, single-pass observations were made in each pool to establish presence/absence of coho salmon or steelhead, and the number of each species observed was estimated and recorded. SCWA staff employed a two-phase survey design on Sheephouse Creek to estimate fish abundance. The two-phase survey design was developed by David Hankin from Humboldt State University Department of Fisheries and is described in Cook et al. (2002).

Snorkeling surveys were conducted on an approximate 3.3-km-reach of Sheephouse Creek between September 27 and October 5, 2000. Surveys were conducted in 122 of 157 total pools in the study reach (78 percent). A total of 450 YOY and 195 steelhead greater than one year (age 1+) were observed during the surveys. Other species observed included sculpin and suckers. No coho salmon were observed in Sheephouse Creek. The estimated population of YOY steelhead in Sheephouse Creek was 680 ± 60, based on the snorkel-survey results. It was not possible to estimate total population for the age 1+ class of steelhead.

Snorkeling surveys were conducted on an approximate 2.5 km-reach of Green Valley Creek between August 22 and September 6, 2001. Snorkel surveys were conducted after CDFG collected 212 coho salmon from the sampling reaches for a hatchery captive broodstock program. Surveys were conducted in 43 of 98 total pools in the study reach (44 percent). A total of 230 YOY steelhead, 78 age 1+ steelhead, and 422 YOY coho salmon were observed during the surveys. Other species observed included roach, stickleback, green sunfish, and sculpin.

Cook (2003b) examined the extent of potential rearing habitat in the mainstem of the Russian River. The study area extended 106 km along the river from Ukiah to Healdsburg and included four reaches, the Ukiah, Canyon, Alexander Valley, and Healdsburg reaches. Dive surveys were conducted in summer and fall 2002 to count fish at randomly selected river segments, and habitat characteristics were recorded. Steelhead distribution and relative abundance are presented in Figure 2-5.

Steelhead were observed in all four study reaches, but their distribution and numbers varied substantially. The distribution of steelhead was correlated with water temperatures. Maximum water temperatures of study reaches generally increased in a downstream direction, and data collected during dive surveys were comparable to permanent temperature stations located in the study reaches. Steelhead in the Ukiah and Canyon reaches (with survey site maximum temperatures of 22ºC and 22.5ºC, respectively) appeared "healthy and vigorous." The highest temperatures occurred in the Alexander Valley and Healdsburg reaches (25ºC and 24ºC, respectively), which may be a factor in the lower fish counts. Habitat also appeared to be a factor. Steelhead were almost exclusively found in riffle and cascade habitats, but were seldom seen in flatwater and deep pool habitats. Food transport in faster water may help steelhead to grow in relatively high water temperatures. Riffle and cascade habitats were most frequently found in the Canyon reach. Species and habitat composition are summarized in Figure 2-6.

2.2.4.3 SCWA's Inflatable Dam /Wohler Pool Fish Sampling Program

SCWA's inflatable dam/Wohler Pool Fish Sampling Program is a 5-year study designed to assess effects to salmonids associated with operation of SCWA's inflatable dam facility. The dam impounds approximately 5.1 km (3.2 miles) of river, creating a long pool (the "Wohler Pool").

A pilot study was conducted in 1999 to assist in developing the study plan for the Mirabel inflatable dam/Wohler Pool Fish Sampling Program. The sampling program was initiated in 2000. Results of fish sampling activities conducted during the pilot study (1999) and the first three sampling seasons (2000-2002) are summarized below.

The sampling program has several components:

- Water-temperature monitoring in Wohler Pool to evaluate the thermal regime in the pool, to determine if the impoundment results in an increase in the rate at which water warms as it passes through the Wohler Pool, and to determine if the pool becomes thermally stratified during the summer months.

- Characterization of the fish community in the Wohler Pool, using electrofishing sampling, to determine species composition and to assess the relative abundance of predatory fish (on salmonids) above the inflatable dam.

- Evaluation of hatchery steelhead smolt emigration through the Wohler area using radio telemetry to determine if operation of the inflatable dam affects smolt emigration.

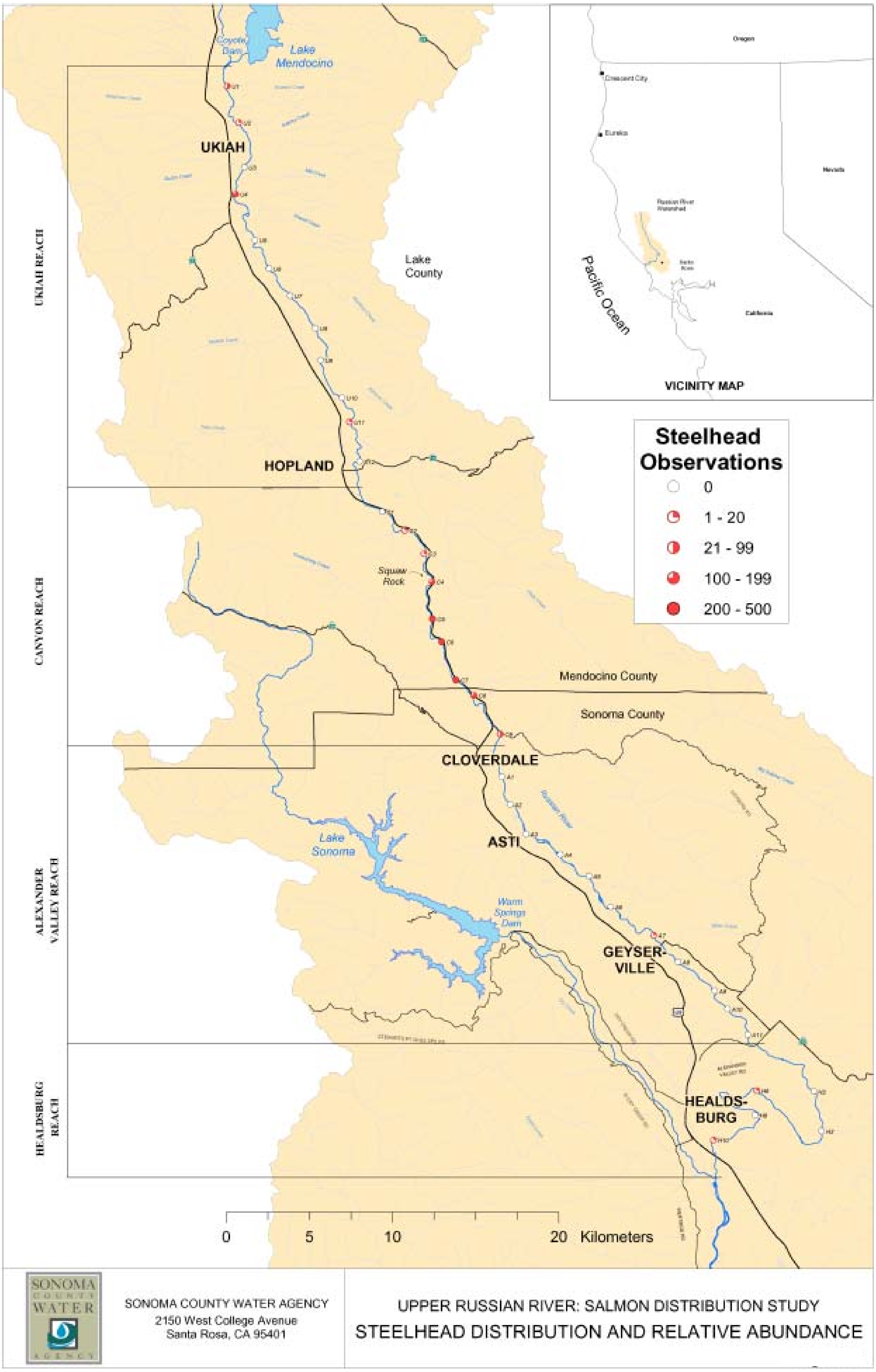

Figure 2-5 Steelhead Distribution and Relative Abundance in 2002 (Cook 2003)

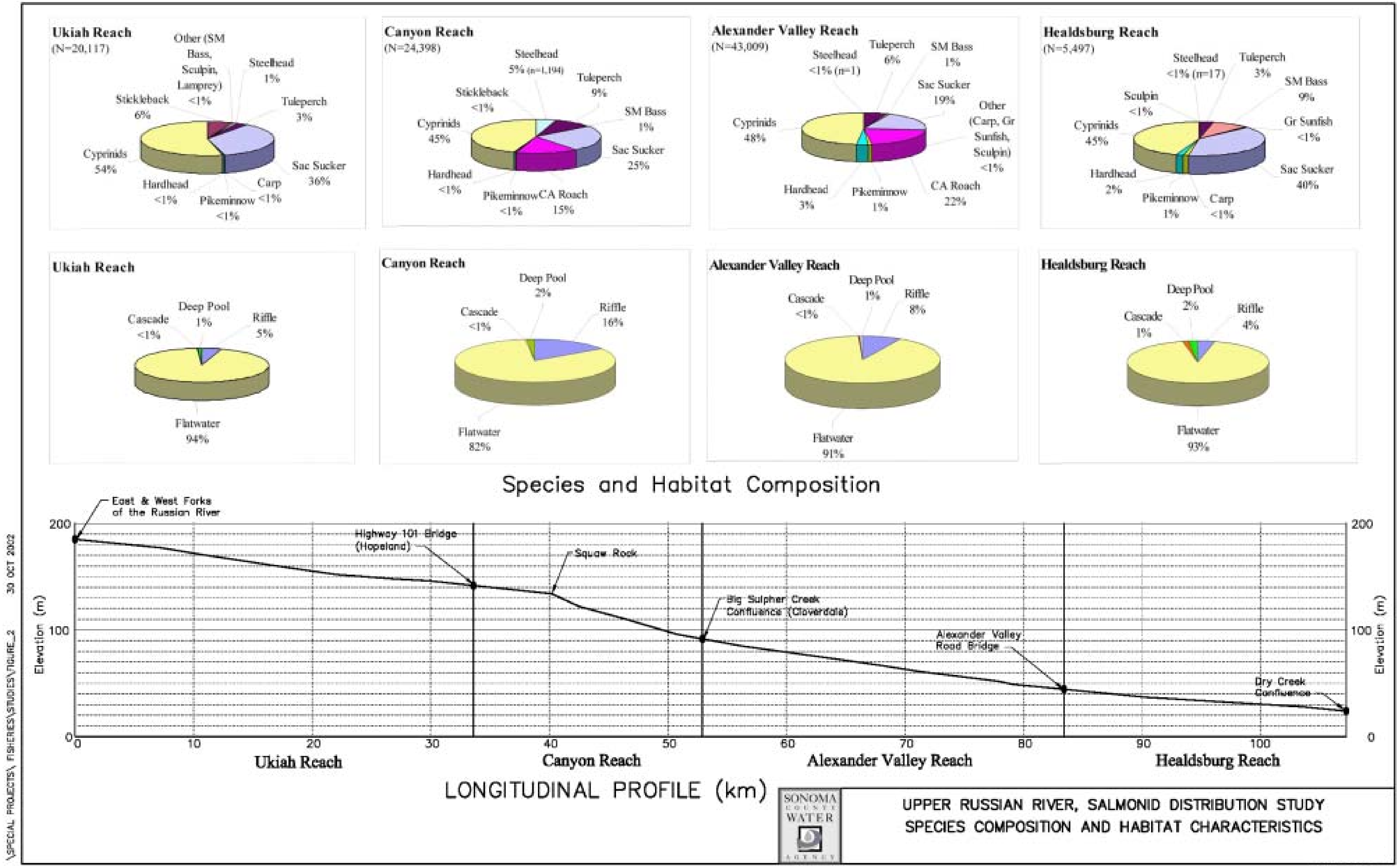

Figure 2-6 Russian River Mainstem Species Composition and Habitat Characteristics (Cook 2003)

- Timing and relative abundance evaluation, using rotary screw traps, of Chinook salmon and steelhead smolt emigration past the inflatable dam.

- Monitoring adult upstream migration to verify that anadromous fish are able to successfully ascend the existing fish ladders located at the inflatable dam.

Monitoring adult upstream migration and the evaluation of the timing and relative abundance of Chinook salmon and steelhead smolt emigration provide information relevant to the status of listed fish species in the Russian River. This program is described briefly below.

Smolt Emigration

The objective of this sampling program is to collect information on wild salmonid smolts emigrating through the study reach.

<u>Methods</u>

A passive sampling methodology (rotary screw trap) was used to capture fish as they migrated past the trapping site (located approximately 60 meters downstream of the inflatable dam). Rotary screw fish traps are designed to capture downstream migrating juvenile fish.

Two sizes of rotary screw traps were operated during the 1999-2002 sampling seasons: an 8-foot-diameter trap was used prior to inflation of the dam, and one or two 5-foot-diameter traps (depending on flow conditions) were used after the dam was inflated. During the 2002 sampling season, one 8-foot-diameter trap and two 5-foot-diameter traps were operated concurrently throughout the trapping season. Table 2-7 summarizes the dates of operation of the rotary screw traps and the dates of operation of the inflatable dam for 1999-2002.

A mark-recapture study was conducted in 2001 and 2002 to estimate the number of Chinook salmon smolts migrating past the dam. A subsample of Chinook salmon smolts (> 60 mm FL) were marked with a partial caudal clip and released approximately 0.8 km upstream of the traps (this was above the dam, when inflated). The percentage of marked smolts recaptured was used to estimate the total number of smolts passing the traps. Trapping began after the Chinook salmon run had begun in 2001; therefore, the numbers presented do not represent a seasonal total. Trapping began at the start of the emigration period in 2002, although the mark recapture phase of the study was delayed until the average size of Chinook salmon exceeded 60 mm FL. Fish captured by the screw traps were removed daily, identified to species, measured, and released into the river.

Trapping data provided information on species composition and timing of emigration past the inflatable dam. Trapping also allowed for the collection of size and age data, and allowed for the collection of tissue for DNA sequencing. Variations in study conditions (such as the number of days of trapping and river discharge) do not allow a comparison of juvenile counts between years.

Table 2-7 Dates of Operation of Rotary Screw Trap, 1999 to 2002

1999														
April														
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
May														
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**[1]	**14**	**15**
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**

One 8-foot-diameter trap in operation.

One 5-foot-diameter trap in operation.

[1]Dam inflated on May 13, 1999.

2000														
April														
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
May														
1	**2**[1]	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
June														
31	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**

One 8-foot-diameter trap in operation.

One 5-foot-diameter trap in operation April 25 - May 2, 2000.

Two 5-foot-diameter traps in operation May 2, 2000 - June 29, 2000.

[1]Dam inflated on May 2, 2000.

Table 2-7 Dates of Operation of Rotary Screw Trap, 1999 to 2002 (Continued)

2001														
April														
16	17	18	19	20	21	22[1]	23	24	25	26	27	28	29	30
May														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
June														
31	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Two 5-foot-diameter traps in operation between afternoon of April 19, 2001 and June 7, 2001. Traps were not operated on April 22, May 28, or May 29 due to insufficient flows.

[1]Dam inflated on April 22, 2001.

2002														
March														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
April														
31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16[1]	17	18	19	20	21	22	23	24	25	26	27	28	29
30														
May														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
June														
31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

Traps installed the afternoon of February 28, 2002. One 8-foot-diameter trap and two 5-foot-diameter traps operated concurrently through April 23, 2002.

[1]Dam inflated on April 16, 2002.

Results

Results of the trapping data are presented in Table 2-8.

Table 2-8 Juvenile Salmonids Captured in the Rotary Screw Traps, 1999-2002

Species	1999[1]	2000[2]	2001[3]	2002[4]
Wild Steelhead – Smolts	107	134	53	250
Wild Steelhead – Young-of-the-Year	69	763	150	5,843
Wild Chinook Salmon – Smolts	193	1,361	3,722	19,319
Hatchery Steelhead – Smolts	31	68	8	1,825

[1]Traps operated for 19 days between April 21 and May 29, 1999.
[2]Traps operated for 81 days between April 7 and June 29, 2000.
[3]Traps operated for 46 days between April 19 and June 7, 2001.
[4]Traps operated between March 1 and June 27, 2002.

The number of wild smolts is substantially greater than the count of hatchery smolts in 1999-2001, while the number of hatchery smolts is substantially greater than the count of wild smolts in 2002. This may be a reflection of the study period. In years 1999-2001, the study period occurred primarily after the latest (mid-April) release dates of hatchery smolts, but in 2002 the study period began on March 1 and was within the period of hatchery releases. The substantial numbers of YOY steelhead may be associated with high tributary flow conditions, may indicate that some spawning and juvenile rearing occurs in the lower and middle mainstem (in which case survival may be low), or may indicate that steelhead fingerling migrate to rearing areas in the Estuary.

1999 Sampling Season Results and Significant Findings

During the 19 days of sampling (between April 21 and May 29, 1999), a total of 193 Chinook salmon smolts, 107 wild steelhead smolts, and 69 wild steelhead YOY were captured in the rotary screw traps (Table 2-8). Although the data collected in 1999 were limited due to the intermittent sampling schedule, the study marked the first time that Chinook salmon smolts were captured in the river in significant numbers. The results of the 1999 sampling effort redirected the focus of the trapping study to include the collection of basic life-history data on Chinook salmon smolts in addition to assessing the effects of the dam on steelhead emigration.

2000 Sampling Season Results and Significant Findings

A total of 1,361 Chinook salmon smolts were captured between April 8 and June 28, 2000. The number of Chinook salmon smolts captured daily remained high through May and rapidly declined during the last two weeks of June. Although the start of the Chinook salmon smolt emigration period could not be determined from the data collected in 2000, the emigration period extended (at a very low level) through June.

A total of 134 steelhead smolts were captured throughout the 2000 trapping season. Steelhead smolts were captured primarily in April and May, with low numbers of wild smolts captured through mid-June.

A total of 763 wild steelhead YOY were captured from April 10 through June 29, 2000. The large number of steelhead YOY observed may indicate that suitable spawning habitat is present in the mainstem Russian River in the vicinity of the inflatable dam. It is also possible that the YOY were washed out of upstream (mainstem and tributary) spawning habitat by a storm on April 16. Although comprehensive habitat surveys have not been conducted in the Wohler Pool vicinity, SCWA fisheries biologists have not observed suitable spawning substrate during monitoring activities in the Wohler Pool.

A few steelhead YOY were also captured in the Wohler Pool during August electrofishing surveys. These fish were generally larger than similar aged steelhead captured in Mark West and Santa Rosa creeks during fall surveys conducted by SCWA. The larger size suggests that some of these YOY were rearing in the mainstem river in the vicinity of the Wohler Pool. However, it is also possible that the YOY captured during boat electrofishing surveys drifted downstream from more upstream mainstem rearing habitat.

2001 Sampling Season Results and Significant Findings

In 2001, the river configuration below the dam changed, resulting in improved trapping conditions. Prior to 2001, the river channel below the dam was relatively uniform in depth across the channel with no discernable thalweg. In 2001, a small island formed in the middle of the channel, resulting in a split channel with the flows being concentrated along shorelines at both moderate and low flows. This channel configuration resulted in two well-defined thalwegs that concentrated emigrating fish and greatly improved trapping efficiencies over the previous years.

During the 46 days of sampling conducted between April 19 and June 7, 2001, 3,722 Chinook salmon smolts, 53 wild steelhead smolts, and 150 wild steelhead YOY were captured in the rotary screw traps (Table 2-8). A mark-recapture study was conducted for Chinook salmon from May 3 through June 5, 2001. Estimates of smolt emigration past the trap ranged from 18,511 using the weekly capture efficiencies, to 20,341 using the seasonal capture efficiency. During the five-week mark-recapture study period, 2,314 Chinook salmon smolts were actually caught. The estimates presented do not represent a seasonal estimate of smolt abundance since the first part of the emigration period was not sampled.

2002 Sampling Season Results

The rotary screw traps were deployed on February 28, 2002. During the period of sampling between March 1 and June 27, 2002, a total of 19,319 wild Chinook salmon smolts, 250 wild steelhead smolts, and 5,843 wild steelhead YOY were captured in the rotary screw traps (Table 2-8). Increased numbers of salmonids captured in the screw traps in 2002 may be in part due to increased trap efficiency (one 8-foot-diameter trap and two 5-foot-diameter traps were operated concurrently throughout the trapping season), and may also be associated with yearly population variability. The large number of steelhead YOY observed in 2002 (as in 2000) suggests that steelhead are spawning and rearing in the mainstem Russian River.

In 2002, the beginning of the smolt emigration period was sampled for the first time. Chinook salmon smolts were first captured in the trap on March 1, 2002 (three fry averaging 38 mm FL). Numbers and size of fish slowly increased in March and April, and numbers peaked in late April/early May. A mark-recapture study was initiated on March 26. Based on recapture rates and estimated trap efficiency, approximately 215,875 Chinook salmon smolts were estimated to have emigrated through the study area by late June.

Adult Upstream Migration and Juvenile Migration through Fish Ladders

The main objective of video monitoring was to verify that anadromous fish are able to ascend the denil fish ladders that provide access past the dam. A secondary objective assessed the timing of migration and relative numbers of anadromous fish utilizing the fish ladders while the dam was inflated. Monitoring of upstream migration was conducted only while the dam was in operation.

<u>Video Monitoring Methods</u>

Two study methods were employed to evaluate fish passage through the fish ladders. Time-lapse video photography was used to document fish passage through the fish ladders, and direct (snorkel) observations were conducted in 1999-2001 to determine if large numbers of salmonids were holding below the dam. Snorkel surveys were of limited use during higher flows due to poor visibility and safety concerns in the area below the dam. At lower flows, snorkel surveys were effective in verifying that significant numbers of adult fish were not holding below the dam.

Underwater video cameras were located at the top of the ladders. The cameras generally recorded the movement of adult fish through the ladders 24 hours per day throughout the time period that the dam was inflated. When the dam was deflated, the fish ladders became inoperable; thus the cameras were pulled at that time. Table 2-9 summarizes the dates of video monitoring for 1999-2002. Video monitoring was continuous throughout the study period, with a few exceptions (e.g., short-term system malfunctions).

In 1999 and 2000, monitoring began in May, soon after the dam was inflated. In 2001, monitoring was initiated in August (although the dam was inflated on April 22, 2001) because results of 1999-2000 monitoring indicated that adult salmonids were rarely using the fish ladders prior to August. In addition, monitoring conducted in 2000 continued through early January because conditions required the dam to be in operation longer.

Table 2-9 Dates of Video Monitoring, 1999 to 2002

Study Year	Date Dam Inflated	Date Dam Deflated	Dates of Video Monitoring
1999	May 13	Nov 14	May 20 – November 16
2000	May 2	Jan 10	May 12 – January 10
2001	April 22	Nov 13	August 7 – November 13
2002	April 16	Dec 11	August 6 – December 10

<u>Video Monitoring Results, 1999-2002</u>

Operation of the dam and fish ladders generally occurs between May and November, which coincides with a portion of the Chinook salmon migration period. (Chinook salmon migrate upstream primarily from September through December.) Steelhead and coho salmon begin their upstream migrations later in the year, often after the dam is removed, and are therefore less likely to be observed during video monitoring.

Species observed entering the fish ladders included Chinook salmon, chum salmon, steelhead, Pacific lamprey, American shad, Sacramento pikeminnow, hardhead, Sacramento sucker, smallmouth bass, common carp, and white catfish. Most of the non-anadromous species were noted as "milling about" in the exit boxes, as opposed to migrating upstream or downstream through the fish ladders. Detailed counts were made of anadromous fish and large cyprinids (potential predators) only. Observations of Chinook salmon and steelhead are described below. Adult coho salmon were not identified during video monitoring.

<u>Chinook Salmon Results</u>

Table 2-10 summarizes monthly counts of adult Chinook salmon observed migrating through the existing adult ladders at the inflatable dam during the 1999-2002 study seasons based on video monitoring.

Although only a fraction of the Chinook salmon migration was monitored in 1999, adult Chinook salmon were observed migrating through the fish ladders in numbers larger than previously believed to exist in the river. Chinook salmon were first observed in the fish ladder on August 26, 1999, but the majority was counted between October 27 and October 30.

In 2000, the entire Chinook salmon run was monitored for the first time. A total of 1,322 Chinook salmon were identified with an estimated run of 1,500 fish migrating above the dam. The Chinook salmon run began in early September, peaked in late November, and ended in late December.

Table 2-10 Monthly Counts of Adult Chinook Salmon Observed Migrating through the Inflatable Dam Fish Passage Facilities, 1999 to 2002

Date	1999	2000	2001	2002
May	0	0	--	--
June	0	0	--	--
July	0	0	--	--
August	1	1	1	9
September	12 (3)[1]	88 (5)	25	176
October	145 (76)	670 (63)	759 (10)	2,329
November	47 (12)	492 (51)	514 (74)	2,889
December	--	71 (37)	--	63[1]
January	--	0	--	--
Totals	**205 (91)**	**1,322 (156)**	**1,299 (84)**	**5,466 (9)**

[1]Numbers in parentheses are salmonids that could not be positively identified, but based on timing and percentages of fish that were identified, were likely Chinook salmon.

A partial run count of 1,299 adult Chinook salmon through November 13, 2001, which occurred prior to the peak of the run, suggests the 2001 run was substantially higher. Fish were still being counted when the dam was deflated, indicating that the run continued beyond the study period.

Between August 8 and December 10, 2002, a total of 5,466 adult Chinook salmon were observed. Substantial numbers of Chinook salmon were observed in early October, but the largest peak numbers occurred in early November.

Average daily water temperatures during the 2000 Chinook salmon migration ranged from 20.4°C on August 24 (date the first Chinook salmon was observed in the fish ladder) to 9.8°C during mid-November. The temperature on September 7 (the date that the run essentially began at the dam) was 19.5°C, and temperatures exceeded 20.0°C for seven consecutive days in mid-September. Thirty-six Chinook salmon were observed in the fish ladder during this period. The weekly average water temperature was 14.7°C during the peak of the Chinook salmon migration period (last week of October).

Adult Steelhead Results

Winter-run adult steelhead migrate to their spawning grounds from November through June, typically peaking between December and March. The dam is seldom inflated during much of this time period; as a result, most of the steelhead spawning migration occurs outside of the sampling period. The number of steelhead recorded in the fish ladders represents only those fish migrating when the dam was inflated, and cannot be used as an estimate of steelhead abundance. Steelhead were divided into three categories: wild fish (possessing an adipose fin), hatchery fish (adipose fin clearly clipped), and unknown origin (could not be clearly determined if the adipose fin was clipped or not).

Adult steelhead were not observed in the fish ladders during the 1999 or 2001 sampling seasons. A total of 532 adult steelhead were observed in the fish ladders between May 15, 2000 and January 10, 2001 (consisting of 110 wild steelhead, 252 hatchery steelhead, and 170 steelhead of unknown origin). Adult steelhead were observed in the fish ladder in every month that the cameras were operated, except August and September. The run of wild adult steelhead above the dam was completed prior to the installation of the video cameras on May 6, 2000. After this date, four adult steelhead were identified as being wild. The numbers of steelhead identified in the ladders slowly increased during November, with relatively large numbers of steelhead migrating through the fish ladder beginning in December.

Steelhead were observed migrating upstream through the fish ladders at streamflows similar to those discussed for Chinook salmon. Adult steelhead were observed in the fish ladders when average daily temperatures exceeded 20.0°C on several occasions during the spring and early summer, with one fish ascending the ladder when the average daily temperature exceeded 24°C. However, water temperatures during mid-November when the upstream migration began in earnest ranged from approximately 10.0°C to 12.0°C.

Juvenile Steelhead Results

Wild and hatchery smolts, and smolts of undetermined origin, were observed passing through the fish ladder throughout the study. In addition, several steelhead smolts were observed entering the exit boxes, "milling about," and leaving the box in the same direction from which they originally entered. Since it was possible that at least some of the observations were the same fish passing upstream and downstream repeatedly through the boxes, it was not possible to estimate the number of fish moving past the dam during any study year. However, observation of juvenile steelhead indicates that at least a few juvenile steelhead inhabit the Russian River in the vicinity of the Mirabel inflatable dam throughout the summer.

2.2.5 Genetic Variance in Coho Salmon, Steelhead, and Chinook Salmon

A key feature of the ESU concept is conservation of genetic resources that represent the evolutionary legacy of a biological species (Waples 1996). The ESA mandates the restoration of listed species in their natural habitats to a level at which they can sustain themselves without further legal protection, so there is a focus on protecting naturally spawning populations. The ESA also recognizes that conservation of listed species may be facilitated by artificial means (Hard et al. 1992). Information on the genetic variance within and between naturally and artificially spawned populations is used to develop recovery programs and assess their effects on conservation of genetic resources within the Russian River basin.

Early work based on protein electrophoresis has formed an important basis for identification of salmon and trout population structure for management and conservation. Protein electrophoresis detects variation (allozymes) for a portion of the genome, the one that codes functional proteins.

Much of the recent genetic data are based on DNA analysis. Analysis of nuclear DNA (e.g., microsatellite DNA) detects differences at a more fundamental level — the nucleotide sequence — and therefore may potentially resolve smaller genetic differences between populations and individuals. Only minute amounts of tissue are needed for microsatellite (or mitochondrial [mtDNA]) analysis and this enables the use of nonlethal sampling methods on endangered and threatened fish. Alleles are different forms of a gene at a single gene locus. For example, a gene in an individual may contain one allele that codes for blue eyes and one for brown eyes. Allelic differences are used to measure genetic variation.

Genetic differences accumulate between populations that are strongly reproductively isolated from each other because gene flow is substantially reduced. Mutation and random genetic drift in isolated populations cause genetic differences to accumulate. These differences are used to measure the relative degree of reproductive isolation between populations (genetic distance) and to create phylogenetic trees that illustrate the relationships between populations and groups of populations. These genetic relationships can be compared to geographic distances to see if they are correlated. Fish are more likely to stray (resulting in gene flow between populations) between streams that are geographically closer to each other. Alternatively, out-of-basin stock transfers may reduce genetic differences between populations, but disrupt beneficial local adaptations that have a genetic basis. The relative amounts of genetic diversity within (F_{IS}) and between (F_{ST}) populations, which can affect the ability of a species to persist over the long term, can be quantified.

This section summarizes information on the genetic variance of coho salmon, steelhead, and Chinook salmon.

2.2.5.1 Coho Salmon

NMFS (1995) examined the genetic relationships of California and southern Oregon coho salmon populations by combining allozyme data from NOAA Fisheries samples with data from Olin (1984) and Bartley et al. (1992). Two major geographic clusters were apparent and separated by a relatively large genetic distance (D = 0.126[1]). The northern, primarily large river group (within the Southern Oregon/Northern California Coast ESU directly to the north), included samples from the Elk River (near Cape Blanco) to the Eel River (just north of Cape Mendocino). The southern, primarily small river group, included nine samples from Fort Bragg to Tomales Bay (Lagunitas Creek), as well as three samples from north of Cape Mendocino. Considerable genetic diversity among populations was apparent within both groups.

The Willow Creek sample from the Russian River clustered with the Huckleberry Creek sample from the South Fork Eel River, but not with other creeks in the Eel River, which were more closely related to rivers to the north. Willow Creek clustered loosely with other proximate streams such as Lagunitas, Navarro, or Russian Gulch.

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[1]Cavalli-Sforza and Edwards (1967) Chord distance (D) was used.

The Bodega Marine Laboratory (BML) used nuclear DNA to document coho salmon population diversity within the California Central Coastal (CCC) ESU, with a special emphasis on the Russian River basin (Hedgecock et al. 2003). Low numbers of spawners in the Russian River watershed have resulted in extensive reliance on the sampling of juveniles, so molecular markers were developed to distinguish coho salmon from Chinook salmon and steelhead.

The BML study generally supported the California ESU structure which includes the CCC, the South of San Francisco ESU recognized by California's ESA, and the Eel and Mattole River samples from the Southern Oregon/Northern California ESU. However, even after the genetic tree was adjusted for admixture and family structure, the node separating the South of San Francisco ESU and a large proportion of the CCC ESU was not supported. Green Valley Creek in the Russian River and Redwood Creek in Marin were outliers in the genetic tree.

Russian River Basin Samples

Coho salmon from the Russian River watershed and from streams in Marin County were collected for the Russian River coho salmon captive broodstock program. Results of the BML study and of genetic research at the NOAA Fisheries South West Science Center, Santa Cruz Laboratory (NOAA Fisheries Santa Cruz Laboratory) are being used to assess the genetic diversity of these populations and to identify suitable source populations for the captive broodstock program.

Juvenile samples from Green Valley Creek from 1997, 1998, and 2000 were assessed for their level of inbreeding and compared to samples from hatchery populations and from other watersheds within the ESU (Hedgecock et al. 2003). The Green Valley 1998 samples had high levels of inbreeding. The effective number of breeders in this tributary was estimated as 10, which suggests this population has undergone a population bottleneck and may be subject to a substantial amount of genetic drift. The study concluded the risk of inbreeding in the coho salmon captive broodstock program would be high if Green Valley Creek fish were used or were not interbred with populations from a neighboring watershed (such as Lagunitas or Olema creeks). The Green Valley samples were also very different from Russian River hatchery samples. The homogeneity of samples from Lagunitas Creek (in Marin County) from different year classes and tributaries was found to contrast with the heterogeneity of samples in other drainages. Stocking history, which could influence the relationships between populations, was not researched for Lagunitas Creek.

Samples from Green Valley Creek were distant from other populations. The 2000 samples, which were the most distant, were very different from Lagunitas (F_{ST} values[2] of 0.101 to 0.109) and Olema (F_{ST} 0.132 to 0.134), suggesting that there could be a substantial risk of outbreeding depression if these populations were interbred. (Outbreeding depression is the phenomenon of decreased fitness following hybridization

[2]F statistics (Wright 1931, 1943) measure the average genetic correlations between populations. An FST=1.0 between two populations indicates very divergent populations.

of individuals from populations with divergent genetic composition, which can occur when out-of-basin stocks are used in a hatchery program. Coadapted gene complexes may be disrupted or local adaptations can be lost.) Additional samples evaluated by the NOAA Fisheries Santa Cruz Laboratory showed that Green Valley fish collected for the captive broodstock program were closely related to fish collected from two other watersheds in the Russian River (Mark West and Maaccama creeks). This indicates that a unique Russian River basin stock that is not closely related to the Lagunitas and Olema creek populations or to coho salmon stocked in the past by the DCFH, may currently exist (C. Garza, NOAA Fisheries Santa Cruz Laboratory, pers. comm. 2003). A large number of alleles present in Russian River populations but not in Lagunitas populations suggest that the Russian River populations may have local adaptations.

The NOAA Fisheries Santa Cruz Laboratory is undertaking a comprehensive genetic assessment of population structure and demography for coastal populations of coho salmon in central California, and will develop baseline genetic information for use in future monitoring and propagation efforts. The research project is designed to evaluate and document differences between the genetic composition of wild fish and artificially introduced fish. The laboratory will analyze tissue samples from coho salmon collected for the captive broodstock program at DCFH to develop a mating scheme. These data will be used to evaluate the relative risks between inbreeding and outbreeding depression as the capture, mating, and release protocols are developed for the captive broodstock program.

2.2.5.2 Steelhead

Allozyme studies presented in Busby et al. (1996) show a great deal of genetic variability among populations of this ESU. Samples from Coleman National Fish Hatchery and two tributaries in the Sacramento River Basin cluster distinctly from other steelhead in this ESU. Another cluster includes streams from this ESU (Lagunitas, Scott, San Lorenzo, Alameda, Arroyo Hondo, and Gaviota) but also includes the Ten Mile River sample in Mendocino County north of the Russian River, and Whale Rock near San Luis Obispo in southern California. An anomalous geographic structure was detected in this allozyme study. Though modest differences were found between samples from Ten Mile River and Lagunitas Creek, these samples were also found to be more similar to the Whale Rock Hatchery (near San Luis Obispo) samples than to populations geographically closer (Scott Creek and San Lorenzo). Nielsen (1994) found substantial differences in frequencies of some mtDNA alleles between Mendocino and Marin County samples, but the Ten Mile River and Lagunitas Creek allozyme data did not reflect this, as seen by their relative similarity.

Nielsen et al. (1994) included Russian River samples in a study that found biogeographic distribution of mitochondrial and nuclear DNA in naturally spawning coastal steelhead in California. Data for both mtDNA and a single microsatellite locus (Omy77) gave significant differentiation between three broad bioregions: north coast, central coast (Russian River to Point Sur), and south coast. Six steelhead hatchery populations (Van Arsdale Hatchery on the Eel River, Van Duzen River Hatchery, DCFH on the Russian River, Big Creek Hatchery near Scott Creek, San Lorenzo River hatchery in Santa Cruz, and Whale Rock Hatchery near Morro Bay in southern California) did not show significant biogeographic structuring of mtDNA genotypes, but were dominated by mtDNA types that were most common in their general geographic area. Similarly, no significant biogeographic association with Omy77 was detected.

In a study that compared hatchery stocks and geographically proximate populations of anadromous salmonids, hatchery stocks of steelhead carried significantly more mtDNA types than geographically proximate wild populations (Table 2-11) (Nielsen et al. 1994). The authors suggest that the abundance of these rare mtDNA types in hatchery stocks may be due to historic stock transfers that introduced divergent lineages into hatchery stocks.

Table 2-11 The Number of *O. mykiss* mtDNA Types Found Only in Wild or Hatchery Populations in Paired Comparisons of Geographically Proximate Populations, Based on Fish Sampled from 1990 to 1993 (Nielsen, Gan, and Thomas 1994)

Location	Number of mtDNA Types	
	Wild Only	Hatchery Only
Eel River	0	3
Russian River	1	2
Big Creek Hatchery	0	3
Whale Rock Hatchery	1	2
Total	**2**	**10**

The NOAA Fisheries Santa Cruz Laboratory is conducting further analysis of the genetic structure of coastal populations of steelhead. A study is also underway to compare steelhead populations upstream and downstream of 10 impassable barriers in the Russian River, and to conduct a phylogenetic analysis within the Russian River watershed (Deiner et al. 2002). Preliminary review of data from populations above and below a passage barrier on Mill Creek found differences between the populations and found unique alleles in the population above the barrier.

2.2.5.3 Chinook Salmon

It is not known whether historically there has been a persistent Chinook salmon population in the Russian River. Data from the inflatable dam monitoring program have documented a naturally spawning population in recent years, despite the suspension of hatchery production in 1999 (Chase et al 2001, 2002). Given the high level of interbasin transfers over many years, and that the sources of many of the Chinook salmon planted were streams in what are now considered separate ESUs, naturally spawning Chinook salmon within the river may represent a genetic conglomerate of many stocks. Data, however, are unavailable to quantify the degree of introgression. Similarly, adults used as broodstock may themselves be descendants of many stocks. Historically, substantial stocking of Sacramento River Chinook salmon into the Russian River has occurred and could have contributed to the current genetic stock structure. Klamath River stocks have also been introduced.

Out-of-basin stocks were planted in the Russian River through 1998. Historically, a large percentage of Chinook salmon planted in the Russian River were from the Sacramento River (38 percent). Several runs of Chinook salmon are found in the Sacramento and San Joaquin rivers (in the California Central Valley ESUs), including spring-, fall-, and late fall-run. The Central Valley historically contained predominantly spring-run fish, but fall-run are currently the most numerous.

Coastal Chinook Salmon Differentiation

Coastal Chinook salmon populations south of Cape Blanco, Oregon, are substantially different morphologically and physiologically from populations to the north. Moreover, there is finer scale differentiation between shorter coastal systems and the two larger river basins, the Rogue and Klamath rivers (Myers et al. 1998).

In a recent study in the Chinook salmon status review (Myers et al. 1998), allelic frequencies for 29 to 31 loci collected over 15 years by researchers at NOAA Fisheries, University of California at Davis, Washington Department of Fish and Wildlife (WDFW), and the Alaska Department of Fish and Game (ADFG) were pooled. A total of 193 populations from Alaska to California were analyzed. A clear separation of populations with ocean-type and stream-type life histories was found. Several distinct subclusters appear among ocean-type samples, including: 1) the British Columbia and Puget Sound rivers, 2) coastal rivers of Washington, Oregon, and California, 3) Upper Klamath River samples, 4) the Columbia River basin, and 5) the Sacramento-San Joaquin River drainage.

The population structure suggested in this status review (Myers et al. 1998) is mostly consistent with previous studies. A California coastal group comprising populations south of the Klamath River, were consistent with Bartley and Gall (1990) and Bartley et al. (1992, cited in Myers et al. 1998). Sacramento-San Joaquin River populations were distinct, and DNA data indicated that winter-, spring-, fall-, and late fall-runs were genetically distinct (Hedgecock et al. 1995; Banks 1996; and Nielsen 1995, 1997).

In addition to the Sacramento River, the Klamath River has been historically a source of Chinook salmon plants into the Russian River (11 percent). Banks et al. (1999) used five microsatellite loci to look at population structure for 11 fall- and spring-run Chinook salmon samples in the Klamath River and compared these samples to Chinook salmon in the Central Valley. Two large clusters in the Klamath River basin populations differed from Central Valley populations. The upstream-most populations in the Klamath River basin (Scott River, Shasta River, and Iron Gate Hatchery) were differentiated from subclusters of fall- and spring-run subclusters in the Trinity and Salmon rivers. The Blue Creek population (from the lower Klamath River) was more similar to southern Oregon and California coastal Chinook salmon populations than to upper Klamath/Trinity River populations.

Additional genetic data analyzed for a Chinook salmon status review update (Busby et al. 1999) helped delineate the California Coastal Chinook ESU (NMFS 1999). In 1998 and 1999, NOAA Fisheries, CDFG, USFWS, and the U.S. Forest Service collected samples from adult Chinook salmon from 13 rivers and hatcheries in the Central Valley and Klamath River basin, and analyzed them along with allozyme data for California and southern Oregon Chinook salmon used in Myers et al. (1998). The population structure in this analysis was consistent with the major genetic groups found in previous studies (Utter et al. 1989; Bartley et al. 1992; Myers et al. 1998, cited in NMFS 1999). The Central Valley group was the most divergent. The remaining samples formed two large groups that included samples from the Klamath River basin and from coastal rivers. Blue Creek clustered with the coastal samples. The coastal river samples contained two subclusters from rivers south and north of the Klamath River. The genetic distances between these two subclusters corresponded roughly to the differences found between Central Valley
spring-, fall-, and late fall-run Chinook ESUs, and the Washington and Oregon coast Chinook ESUs.

MtDNA haplotypes from some fall-run Chinook salmon smolts captured in 1993 and 1994 from the Russian River Estuary did not match haplotypes from the DCFH, and a rare haplotype was found only in Chinook salmon from the Russian and Guadalupe rivers (Nielsen et al. 1994, cited in Busby 1999). Significant haplotype frequency differences between Guadalupe River Chinook salmon and the four spawning runs in the Central Valley were primarily due to the rare haplotype found in two fish in the Guadalupe River but not found in the Central Valley. (The remaining 27 samples from the Guadalupe River were indistinguishable from the Merced River and Feather River hatchery samples.) However, when samples from the Sacramento River drainage and the Guadalupe River from 1991 to 1995 were analyzed, one fish from the 1994 fall-run Coleman Hatchery carried a haplotype previously found only in the 1994 collection from the Guadalupe River, suggesting this stock may be the source of the unique Chinook salmon haplotypes found in the Guadalupe River in 1993 to 1994 (Nielsen 1997).

Genetic studies to date suggest that coastal stocks within the California Coastal Chinook ESU are distinct from stocks in neighboring ESUs. Rare mtDNA haploytypes found in the Russian and the Guadalupe rivers (in separate ESUs) may have been the result of hatchery strays.

Genetic samples collected from naturally produced Chinook salmon juveniles in the Russian River by SCWA in 1999 have been analyzed by the BML to assess their affinity with other coastal Chinook salmon populations (Hedgecock et al. 2003). Samples from Chinook salmon in the Russian River (collected from Forsythe Creek and the inflatable dam area where Chinook salmon migrate through) were compared with samples from the Eel, Klamath, and Trinity rivers, DCFH (two sample sets derived from Eel River stocks), Central Valley, and Santa Clara Valley. No correction for family structure was necessary because samples did not have high levels of linkage disequilibrium. Chinook salmon in the Santa Clara Valley and Central Valley stocks (inland stocks) were closely related. Based on seven loci, coastal Chinook salmon from the Eel, Russian, and Klamath rivers clustered on one side of the dendogram while the inland populations clustered on the other side of the dendogram, which indicates they are genetically different. The Eel and Russian rivers cluster together, but are distinct from one another with a bootstrap value of 919,[3] which indicates they are genetically distinct. These data indicate Chinook salmon from the Russian River were not closely related to Central Valley or Eel River populations. The report concluded that Chinook salmon in the Russian River belong to a diverse set of coastal Chinook salmon populations.

2.2.6 Salmonid Predators

Figure 2-6 shows the species composition found during snorkel surveys conducted in the Russian River mainstem in summer and fall of 2002 (Cook 2003b). Cyprinids and Sacramento suckers dominated most of the observed fish communities. Juvenile cyprinids (California roach, pikeminnow, and hardhead) can be difficult to distinguish and were identified to family when species identification was not possible. Although population estimates are not available, these surveys show that native and non-native species that could potentially compete with or prey upon juvenile salmonids were present throughout the watershed.

Data collected in 2000, 2001, and 2002 during electrofishing sampling (as part of SCWA's inflatable dam/Wohler Pool Fish Sampling Program) indicated that three potential salmonid predators inhabit the Russian River near the inflatable dam: Sacramento pikeminnow, smallmouth bass, and largemouth bass (Chase et al. 2001). Two large striped bass have been captured in four years of sampling, and two others have been observed during video monitoring and snorkel surveys, although, in general, not many have been seen. Adults of each of these species may prey upon juvenile salmonids. However, electrofishing sampling data from 1999 through 2002 indicate that the pikeminnow, smallmouth bass, and largemouth bass populations in the vicinity of the inflatable dam are composed predominantly of juveniles. For example, in 2000, 40 percent (1,349) of all fish captured during SCWA's inflatable dam /Wohler Pool Fish Sampling Program fell in the predatory category. Eighty-five percent (1,148) of the predators captured were YOY, and only 2.6 percent (35) of the predators were age 2+ or older (i.e., large enough to prey on juvenile salmonids). Results from SCWA's 1999 sampling showed a similar predominance of juvenile fish (Chase et al. 2000).

The following sections briefly describe the life history, habitat, and occurrence of each of these potential predatory species in the Russian River.

2.2.6.1 Sacramento Pikeminnow

The Sacramento pikeminnow is native to the Russian River (Moyle 2002). Site-specific information on pikeminnow in the Russian River is limited, and most of what is known about their biology and life history comes from studies conducted in other river systems, primarily in the Sacramento and San Joaquin rivers. This species occupies pools

[3]The significance of nodes in a phylogenetic tree is tested with bootstrap analysis, in which genetic distance is estimated by producing many trees (1,000 in this study). A node is considered significant if it is recovered in more than half of the bootstrap trees (500).

throughout the Russian River and the lower reaches of larger tributaries (Chase et al. 2001). However, estimates of pikeminnow abundance in the Russian River are not available. Sacramento pikeminnow was observed in low numbers (2.8 percent of the total captures) during SCWA electrofishing surveys conducted in August 2000 in the Wohler Pool area.

Pikeminnow prefer warmwater streams with abundant pools (Taft and Murphy 1950; Moyle and Nichols 1973). Pikeminnow generally prefer relatively low-velocity habitat (<15 centimeters per second [cm/s]) except when foraging or moving from one pool to another, moderate depths (0.5 to 2.0 meters), and a substrate of gravel to boulder (Knight 1985).

Pikeminnow juveniles feed on aquatic insects, and, as they grow, switch to a diet primarily of fish (Moyle 2002). Adult Sacramento pikeminnow are known to eat salmon and steelhead smolts (Moyle 2002). Pikeminnow generally begin to include fish in their diet after reaching a length of 165 to 230 mm. A literature review conducted by SCWA staff found three size classes of pikeminnow in terms of the potential to prey on salmonids: pikeminnow that are less than 200 mm FL (where fish are an insignificant part of their diet); those between 200 and 300 mm FL (where fish comprise a small portion of their diet); and those greater than 300 mm FL (where fish comprise a significant part of their diet) (Chase et al. 2001).

2.2.6.2 Smallmouth Bass

Smallmouth bass are an introduced species and are widespread and abundant in the lower Russian River. Smallmouth bass appear to be widespread throughout the mainstem Russian River with peak abundances reportedly occurring in the Alexander Valley (Chase et al. 2001, Cook 2003a). Smallmouth bass was the most abundant species observed during SCWA electrofishing surveys conducted in August 2000 in the Wohler Pool, comprising 34.4 percent of the total captures (Chase et al. 2001).

Edwards et al. (1983) describe optimal habitat for smallmouth bass as cool, clear streams with abundant shade and cover. Smallmouth bass prefer deep, dark hiding areas with cover provided by boulders, stumps, rootwads, and LWD. Optimal water temperatures for growth range from 26 to 29°C, and preferred temperatures range from 21 to 27°C (data cited by Edwards et al. 1983; Carlander 1977). Growth reportedly does not occur at temperatures below 10°C to 14°C (data cited by Edwards et al. 1983; Carlander 1977).

Smallmouth bass will consume a wide variety of food items, including fish, crayfish, insects, and amphibians (Moyle 1976). Smallmouth bass have been documented to feed on salmonids, primarily under-yearling Chinook salmon smolts such as those found in the Russian River. Zimmerman (1999) developed a linear regression for the size of salmonids that could be consumed by smallmouth bass between 200 and 400 mm FL. Based on this regression, a 200 mm smallmouth bass can consume a 100 mm salmonid. Smallmouth bass observed during SCWA electrofishing surveys ranged in size from 50 to 370 mm FL.

2.2.6.3 Largemouth Bass

Little data are available on the abundance and distribution of largemouth bass (an introduced species) in the Russian River. They are apparently confined to the lower sections of the river, but are generally not considered abundant. Largemouth bass were captured in low numbers (approximately 1 percent of the total captures) during SCWA's sampling in the Wohler Pool (Chase et al. 2001), but were not captured during a similar study conducted in 1999 (Chase et al. 2000). They were not observed during snorkel surveys in 2002 (Cook 2003).

In rivers, largemouth bass prefer low-velocity habitats with aquatic vegetation (Stuber et al. 1982; Carlander 1977). Stuber et al. (1982) reviewed the literature on largemouth bass and concluded that optimal temperatures for growth of juvenile and adult largemouth bass range from 24°C to 36°C.

Largemouth bass feed primarily on fish and crayfish after reaching a size of 100 to 125 mm standard length (SL) (approximately 125 to 150 mm FL). The risk of largemouth bass predation on salmonids is low because their habitats seldom overlap. However, salmonids may become vulnerable to largemouth bass predation during the later half of the emigration period when streamflows decrease and water temperatures increase. Under these conditions, largemouth bass are more likely to become active. Largemouth bass will apparently consume any animal that it can fit in its mouth, including small mammals, waterfowl, frogs, and fish.

2.3 UPPER AND MIDDLE REACHES

Three major reservoir projects provide water supply storage for the Russian River watershed: Lake Pillsbury on the Eel River, Lake Mendocino, and Lake Sonoma. Water supply releases from Lake Sonoma and Lake Mendocino are made in accordance with criteria established in 1986 by D1610 (SWRCB 1986b). Flow regulation under D1610 is presented in detail in Section 2.5. Releases from Lake Pillsbury are discussed in Section 2.1.

For the purpose of managing water supply releases from Lake Mendocino and Lake Sonoma, the river can be divided into two sections: the Russian River between Lake Mendocino and Healdsburg; and the Russian River from Healdsburg to Jenner, including Dry Creek. Section 2.3 describes the activities in the upper and middle basin above Healdsburg. The lower basin downstream of WSD is discussed in Section 2.4.

2.3.1 COYOTE VALLEY DAM AND LAKE MENDOCINO

Lake Mendocino is a multipurpose reservoir that provides flood protection to areas below CVD; supplies water for domestic, municipal, industrial, and agricultural uses; and is operated for hydroelectric power generation. Lake Mendocino is the major component of the USACE's Coyote Valley Dam Project (CVDP) (see Figure 2-1 in Section 2.1). It controls runoff from a drainage area of about 105 square miles and stores water from the PVP.

CVD is a rolled earth embankment dam with a crest elevation of 784 feet above mean sea level (MSL), which is 160 feet above the original streambed. Lake Mendocino, which began storing water in 1959, had an original design capacity of 122,500 AF at the spillway crest elevation of 764.8 feet above MSL. A bathymetric (water-depth) study in 1985 (SCWA and USGS 1985) indicated that the storage capacity was 118,900 AF, which is 3,500 AF less than its original capacity. A bathymetric survey conducted in 2001 indicated that the storage capacity is 116,500 AF (P. Pugner, USACE, pers. comm., 2003).

Lake Mendocino has distinct pools for water supply and flood control, determined by the elevation of the water surface. The water supply pool capacity of Lake Mendocino, which was originally 72,300 AF, has been reduced by sedimentation to about 69,000 AF. The capacity above 69,000 AF is used for flood control. SCWA and the MCRRFCD share state water rights permits to store up to 122,500 AFY in the reservoir. SCWA determines releases to be made from the water supply pool. However, when the water level rises above the top of the water supply pool (seasonally between elevations 737.5 feet and 748 feet above MSL) and into the flood control pool, USACE determines releases. USACE also determines releases during inspections and during maintenance and repair of the project. Approximately 12,900 AF of mainstem water rights are senior to SCWA's and MCRRFD's rights to direct diversion and storage in Lake Mendocino. These are not rights to water stored in Lake Mendocino, but only to water that is flowing into Lake Mendocino. Therefore, to the extent that water flowing in Lake Mendocino would be available to satisfy these senior water rights in the absence of the dam, USACE and SCWA must allow water to pass through the CVD to satisfy those rights. An additional 18,000 AF of CVDP water rights are of equal priority to SCWA's rights.

The elevation of the top of the water supply pool in Lake Mendocino changes in the fall and spring months. Approximately 20,000 AF of additional water can be stored for water supply in the flood control pool toward the end of the rainy season (March to April) as the need for flood control storage decreases. USACE decides whether this additional water storage capacity becomes available in March or April. In practice, USACE has allowed the reservoir to fill early under *dry* conditions, beginning as early as February. In October, when the need for flood control storage increases again, the reservoir level must be reduced to its winter level (between 737.5 and 748 feet above MSL).

The operation of CVD has altered year-round mainstem flow patterns. Dam operations reduced discharge peaks, prolonged winter high flows, and increased summer flows up to 200 cfs above Healdsburg. During the rainy season (October through May), natural streamflow (rather than reservoir releases) accounts for most of the flow of the Russian River. From June through September, the natural flow in the Russian River downstream of CVD and above Dry Creek is augmented by water released from Lake Mendocino.

Winter operations primarily involve storing water in the dedicated flood storage space until releases are made for flood control. When possible, releases from CVD are controlled so that flow at Hopland, about 14 miles downstream, does not exceed the 8,000-cfs channel-capacity of the mainstem. This is sometimes not possible when inflow to the lake is very high.

CVD has only a minor effect on winter flood flows at Healdsburg because it controls only 7 percent of the Russian River watershed (and 13 percent of the area above Healdsburg) (USACE 1986). USACE's 1986 study evaluated the effect of CVD on the flood of 1964. The results indicated that operation of the dam reduced the flood peak by 29 percent at Hopland, 14 miles downstream; 21 percent at Cloverdale, 30 miles downstream; 11 percent at Healdsburg, 58 miles downstream; and 7 percent at Guerneville, 74 miles downstream.

During the summer months, water is released from Lake Mendocino to meet water supply demands between Lake Mendocino and Healdsburg, and to meet the required minimum flow at Healdsburg. In general, SCWA does not make discretionary releases from Lake Mendocino for diversions by SCWA or any other diverters below Dry Creek. Releases from the CVD water supply pool are determined by SCWA pursuant to the requirements of D1610. Releases from Lake Mendocino are made from an outlet tunnel 128 feet below the dam spillway crest at the bottom of the reservoir, which means the coolest water is released during summer months.

2.3.1.1 Flood Control Operations of Coyote Valley Dam

USACE's main objective for flood control releases from Lake Mendocino is to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below CVD, to the extent possible. The specific criteria for flood control operations are described in the Water Control Manual for Coyote Valley Dam (CVD Water Control Manual) (USACE, Exhibit A 1998b). The general criteria for releases from the flood control pool, which include all reservoir storage above the top of the water conservation pool, call for successively increasing releases in three stages as reservoir levels rise toward the emergency spillway. The Hopland streamflow gage, 14 miles downstream of CVD, is the most downstream monitoring point for decisions affecting flood control releases from Lake Mendocino.

USACE limits releases from Lake Mendocino to prevent local flooding at Hopland that generally occurs when flows exceed 8,000 cfs. Because bank sloughing is likely to occur when flows decrease too rapidly, USACE has imposed a maximum ramping rate of 1,000 cfs per hour for Lake Mendocino.

USACE has developed modified guidelines for the rates at which releases from WSD and CVD may be changed during flood control operations. The existing Water Control Manuals allow releases to be changed at up to 1,000 cfs per hour when outflows from the reservoir exceed 1,000 cfs. To protect spawning gravel and juvenile salmonids within the Russian River and Dry Creek, USACE has developed interim guidelines for release changes (USACE, Exhibit A 1998), summarized in Table 2-12:

Table 2-12 Ramping Rates when Flows in Mainstem Russian River Exceed 1,000 cfs

Reservoir Outflow	Ramping Rates
0-250 cfs	125 cfs/hour
250-1,000 cfs	250 cfs/hour
>1,000 cfs	1,000 cfs/hour

USACE follows the existing guidelines 90 percent of the time, based on flood control criteria (P. Pugner, USACE, pers. comm., 2000). Ramping rates from 1,000 to 250 cfs/h typically occur in winter or spring as flood control operations reduce flows from much higher rates following storm events. Typically, flows in the mainstem Russian River at Ukiah exceed 1000 cfs when flows are reduced at these rates. Ramping rates of 125 cfs/h, or less, have been used during the low-flow summer months when water supply flows may need to be reduced in order to allow maintenance or inspection of WSD or CVD.

More specific directions are included in Exhibit A to the CVD water control manual, titled “Standing Instructions to Damtenders” (CVD Standing Instructions). Operation for flood control is described by the Flood Control Diagram that is summarized in Exhibit A of the CVD Standing Instructions:

> *Flood Control Schedules 1, 2 and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at the Russian River near Hopland to exceed 8,000 cfs, and (2) the discharge that results in flow at Hopland being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the events, which caused the highest pool at Lake Mendocino. In addition, releases will be limited to (1) at least 2,000 cfs and up to a maximum of 4,000 cfs if the reservoir pool did not reach elevation 746.0 feet, (2) up to a maximum of 4,000 cfs if the highest reservoir pool reached was between elevation 746.0 feet and 755.0 feet, and (3) up to a maximum of 6,400 cfs if the pool exceeded elevation 755.0 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. Schedules 1, 2, and 3 are used if no significant rainfall is predicted.*
>
> *When the QPF*[4] *is 1 inch or more for the next 24 hours or 2 inch or more for any 6-hour period in the next 24 hours, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to 25 cfs within 1 2 hours if necessary (includes 2 hour to travel to control tower and make first gate change). Also, when the flow in*

[4]The Local AWIPS MOS Program (LAMP) quantitative precipitation forecast (QPF) model produces 1- to 22-hour forecasts of precipitation over the conterminous United States.

> *the Russian River at Ukiah exceeds 2,500 cfs and is rising, releases from Lake Mendocino will be reduced to 25 cfs, insofar as possible.*
>
> *Outlet gates may be used when the pool is above the spillway crest (elevation 764.8) for Flood Control Schedule 3 releases, however the sum of the spill and the releases must not exceed 6,400 cfs, subject to the above limitations.*
>
> *The Emergency Release Schedule is used when the pool elevation is above 771.0 feet. Continue to follow the Emergency Release Schedule if the pool elevation is between 771.0 feet to 773.0 feet. At elevation 773 feet and above, the flood control gates are fully open. The flood control gates will remain fully open until the lake has receded below elevation 773 feet. If the pool is receding and is between elevation 773.0 feet and 771.0 feet, follow the Emergency Release Schedule. Flood Control Schedule 3 releases are made when the lake has receded below elevation 771.0 feet.*

Inflows to Lake Mendocino were historically measured directly at the USGS gaging station on the East Fork Russian River, just upstream of Lake Mendocino. This station (USGS Station No. 11461500) measures the runoff from 92 of the 105 square miles of drainage area that contributes to runoff to Lake Mendocino. Flow records for the station are no longer maintained by the USGS. However, stage records are being maintained by the USGS. Inflow to Lake Mendocino is currently computed from change in storage and releases.

Discharge capacity from the reservoir, with all gates open, is 6,500 cfs at the bottom of the flood control pool (i.e., when the water surface elevation [WSE] reaches the stage when the reservoir is converted from water supply operation to flood control operation), and 7,300 cfs at full pool. Releases above this level would require use of the spillway. The design discharge capacity of the spillway is 35,800 cfs.

2.3.1.2 Previous ESA Actions on CVD and WSD Flood Control Operations

To assure the safety, structural integrity, and operational adequacy of these projects, the dams are inspected periodically. Routine inspections include annual pre-flood inspections and more comprehensive five-year periodic inspections; however, inspections and evaluations may be more frequent, if necessary. Nonroutine inspections include post-earthquake inspections. For safety reasons, releases must be reduced or terminated during some portions of these inspections. Normal releases may also be reduced or modified for special testing, such as the outlet works vibration testing carried out in 1998 at WSD. Following formal notification by USACE to NOAA Fisheries, SCWA notifies affected regulatory agencies, including FERC and SWRCB.

USACE has entered into separate formal and informal consultations with NOAA Fisheries since 1997 to address the effects on coho salmon and steelhead resulting from temporary flow reductions or increases from WSD and CVD. In some cases, monitoring was conducted during the time work was scheduled to assess the potential for stranding fry and juvenile salmonids (see Section 2.3.2).

The temporary flow reductions and related actions conducted under previous ESA correlations are summarized as follows:

1. In July 1997, USACE provided NOAA Fisheries with a BA and requested a formal consultation under ESA Section 7 to address the effects of flow reductions resulting from proposed repair work on the EWSL at WSD, and the annual pre-flood inspection at WSD. The EWSL, which supplies water from the WSD outlet works to the DCFH located at the base of WSD,[5] was damaged during high flood releases during a flood event in January 1997. On September 30, 1997, NOAA Fisheries issued a BO and incidental take statement for these activities.

   In November 1997, USACE submitted a supplement to its July 1997 BA to NOAA Fisheries to address a vibration analysis test on the WSD outlet works (USACE 1997). The test, which was intended to determine the cause of damage to the EWSL and outlet works during the January 1997 event, required varying releases from below 50 cfs to over 3,000 cfs over a two-day period. The consultation was requested under 50 CFR (Code of Federal Regulations) Sec. 402.05 (Emergencies), which provides that:

   (a) Where emergency circumstances mandate the need to consult in an expedited manner, consultation may be conducted informally through alternative procedures that the Director of the National Marine Fisheries Service determines to be consistent with the requirements of sections 7(a)-(d) of the Endangered Species Act. This provision applies to situations involving acts of God, disasters, casualties, national defense or security emergencies, etc.

   Due to dam safety concerns relating to the reliability of the outlet works, USACE proceeded with the testing in January and February of 1998. Additional tests were carried out in March 1998. A BO was not issued to USACE for the testing. NOAA Fisheries protested additional tests that USACE performed in March 1998 that were needed to complete the analysis of the vibration phenomena on the EWSL.

2. In July 1998, USACE submitted a BA to NOAA Fisheries to address the effects of flow reductions during periodic inspections at WSD and CVD (USACE 1998). On September 4, 1998, NOAA Fisheries issued a BO and incidental take statement for these activities (NMFS 1998b).

3. In May 1999, USACE submitted a BA to NOAA Fisheries to address the effects of flow reductions during pre-flood inspections at WSD and CVD (USACE 1999a). In June 1999, NOAA Fisheries issued a BO and incidental take statement for these activities (NMFS 1999).

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[5] Operation of the hatchery is described in detail in *Interim Report 2* (Fish Facility Operations) (FishPro and ENTRIX, Inc. 2000).

4. USACE consulted with NOAA Fisheries in February 2000, for emergency repairs to the EWSL at WSD.

   On February 17, 2000, the EWSL at WSD sustained damages during high flood releases of up to 4,000 cfs. Damages to the EWSL consisted of a broken support bracket, which is used to attach the water line to the side of the stilling basin. Due to a significant pressure drop in the fill line observed by project staff during the high releases, there was concern that the EWSL within the outlet tunnel may have sustained damage. On February 23, 2000, NOAA Fisheries issued a letter of concurrence with the proposed action, concluding that the flow reduction was not likely to adversely affect federally listed species or habitat. The terms of concurrence required ramping down/up to be done in 50-75 cfs/hr increments and monitoring of Dry Creek.

   An inspection of the EWSL within the main tunnel and repairs to the broken support bracket were scheduled for February 25, 2000. The inspection required that the releases through the outlet tunnel be halted for two hours. The EWSL was used to supply approximately 28 cfs to the fish hatchery and Dry Creek below the dam. During the reduced flow period, the bracket was repaired and the EWSL within the tunnel appeared not to have sustained any damage during the high releases.

5. USACE consulted with NMFS on March 17, 2000 to inspect the outlet tunnel and perform repairs to the EWSL at WSD and for inspection of the outlet tunnel at CVD as part of the 2000 preflood inspections.

   After consultation with NMFS, USACE conducted preflood inspections at CVD on May 11, 2000. NMFS determined that the flow reduction was not likely to adversely affect federally listed species or habitat. The terms of concurrence required ramping down in 50 cfs/hr increments. NMFS and USACE monitoring teams found that during the ramping-down period gravel bars became dewatered at the confluence of Ackerman Creek and the Russian River, as well as locations upstream. Stranding and mortality occurred. Since USACE did not have an incidental take statement, NMFS requested that normal operations resume. USACE immediately restored normal outflows.

   On May 23, 2000, repairs to the EWSL and inspection of the conduit required a reduction in releases to 25 cfs for four days. Releases were made alternately via the conduit and the EWSL.

   On September 22, 2000, USACE received a letter of not likely to adversely affect federally listed species or habitat for the WSD and CVD reductions in flow.

6. On May 16, 2000, project operators reported abnormal noise from service gate #3 while making gate changes at CVD. Flows were routed from service gate #3 to gate #2 to alleviate the problem. A visual inspection of gate #3 was unsuccessful in determining the cause of the problem, requiring further investigation.

In July 2000, USACE consulted with NMFS to reschedule the CVD outlet conduit inspection, gate testing for CVD, and sonic meter installation at WSD.

On September 22, 2000, USACE received a letter of not likely to adversely affect federally listed species or habitat for the WSD reduction flow.

Starting on October 2, 2000, for a period of 5 days, sonic meters were to be installed in the conduit at WSD, requiring a reduction in outflow. No stranding or mortality occurred downstream.

On October 11, 2000, USACE received a BO from NMFS for the CVD inspection and gate testing.

On October 12, 2000 after inspection of outlet conduit, USACE performed a series of tests on slide gate #3, requiring ramping up to 750 cfs to replicate the conditions under which the noises were first noted. No stranding or mortality occurred downstream.

7. On July 11, 2001, USACE consulted with NMFS for preflood inspection of the outlet conduit and repairs to the outlet conduit at WSD.

   During the week of September 10, 2001, outflow from the dam was reduced to 25 cfs for five days to complete the repairs and inspection. No stranding or mortality occurred downstream. On August 27, USACE received a letter of not likely to adversely affect federally listed species or habitat for the WSD reduction in flow.

8. July 24, 2001, USACE consulted with NMFS for preflood inspection of the outlet conduit and City of Ukiah repairs to the bifurcation plate in the plenum chamber.

   On September 20, 2001, USACE received a BO from NMFS for the CVD inspection and City of Ukiah work.

   On September 25, 2001 releases were stopped for two hours while the USACE inspected the outlet tunnel. Concurrent with the USACE inspection, the City of Ukiah installed a temporary 2-foot inflatable dam within the conduit to allow the city to work in the tunnel while releases of up to 150 cfs were made over the next four days. Once the City’s work was complete releases were dropped to 50 cfs for one hour to remove the temporary dam. However, the City was not able to remove the steel plates used to keep the temporary skirt portion of the dam in place under flow conditions. The City notified USACE of the problems encountered under flow conditions and it was determined that the City would remove them during the 2002 preflood inspection. No stranding or mortality occurred downstream.

9. August 22, 2002, USACE consulted with NMFS for preflood inspection of the outlet conduit. Additionally, during the inspection the City of Ukiah would remove the steel plates left in place from the 2001 repairs.

On September 25, 2002 the USACE received a BO from NMFS for the CVD inspection.

On September 26, 2002 releases were stopped for two hours while the USACE inspected the outlet tunnel and the City removed the steel plates in the plenum floor. No stranding or mortality occurred downstream.

10. On March 28, 2002, USACE consulted with NMFS for preflood inspection of the outlet conduit at WSD.

    On August 14, USACE received a letter of not likely to adversely affect federally listed species or habitat for the WSD reduction in flow.

    On September 25, 2002, outflow from the dam was reduced to 25 cfs for two hours for the inspection. No stranding or mortality occurred downstream.

Additional consultations for preflood inspections at both projects will occur in 2003.

2.3.1.3 Water Supply Operations

During water supply operations, water is released from Lake Mendocino to meet water supply demands between Lake Mendocino and Healdsburg, and the required minimum flow at Healdsburg. Ordinarily, no water is released from Lake Mendocino for diversion by SCWA or any other diverters below Dry Creek. Under current demand, during a normal summer SCWA must release close to, and occasionally exceed, 300 cfs from Lake Mendocino to satisfy all water supply demands and meet the 185 cfs minimum at Healdsburg. During the summer months, flow targets need to be at least 10 cfs to 20 cfs above the minimum flows at Healdsburg to ensure that instream flow requirements are met regardless of fluctuating demands. Because a change in release at Lake Mendocino may take three days to appear at Healdsburg, changes in demand must be anticipated several days in advance.

2.3.1.4 Lake Mendocino Hydroelectric Power Plant

The Lake Mendocino Hydroelectric Power Plant (LMHPP) was completed in May 1986 at a total cost of approximately $22 million. The power plant was added as an external facility to the downstream base of CVD, which was not originally designed to supply a hydroelectric plant (City of Ukiah 1981). The power plant has a total generation capacity of 3.5 MW through two generators rated at 1 MW and 2.5 MW, respectively. The LMHPP is owned and operated by the City of Ukiah. The City of Ukiah operates the project under a 50-year license issued April 1, 1982, by FERC (Project No. 2481-001). The City of Ukiah is a member of the Northern California Power Authority (NCPA). NCPA owns and operates various power generation plants throughout California and provides power to their members. The City of Ukiah uses the LMHPP to supplement other power sources within the city’s system and has no contractual minimum power output requirements to maintain. Power output is determined by the amount of water released from the dam for water supply, minimum instream flow requirements, and flood control, rather than power generation needs.

The hydraulic turbines require flows between 175 cfs and 400 cfs to operate and produce electrical power. Flows below 175 cfs are not sufficient to produce power. Dam flows, which pass through the facility, are maintained at a minimum of 25 cfs.

Water flows are directed through the LMHPP from an outlet tunnel from the dam. The 959-foot-long, 12.5-foot-diameter concrete tunnel extends beneath the dam between its upstream and downstream sides. Flows exiting the facility run through a riprapped channel that merges with the East Fork Russian River approximately 700 feet downstream from the LMHPP.

The City of Ukiah has an agreement with FERC that is endorsed by CDFG and USFWS to provide between 7 cfs and 15 cfs of water to operate the fish hatchery at CVD (FERC 1983). Minimum flow rates were specified for the hatchery facility in accordance with D1610. FERC permit guidelines require the City of Ukiah to maintain DO levels downstream of the LMHPP at 7.5 milligrams per liter (mg/l) at least 90 percent of the time, with a minimum requirement of 7 mg/l, and a monthly median value of 10 mg/l for the year (FERC 1982). When the turbines are in operation and the DO level approaches 7 mg/l, the turbines are shut down and the flow is diverted to the bypass valves. The City of Ukiah continuously monitors the DO level on a computer system.

The City of Ukiah has no control over the level of releases from the dam, and is not currently operating the LMHPP due to minor damage to a diverter wall that controls flows to power plant turbines. The City of Ukiah is in the process of scheduling needed repairs. When in operation, the LMHPP produces an average of 8 to 9 million kilowatt-hours of power, annually.

The City of Ukiah intends to bring the power plant back into operation as soon as possible. A BA will be prepared, with an alternative transition procedure, for submittal to USACE to consult with NOAA Fisheries once they request closure of the slide gates.

2.3.2 Factors Affecting Species Environment within the Upper Russian River

On the mainstem Russian River, potential effects due to flood control operations were evaluated in *Interim Report 1* (ENTRIX, Inc. 2000a). Effects were evaluated for steelhead and Chinook salmon only, since coho salmon do not spawn in the mainstem. The upper and middle reaches, between Ukiah and Alexander Valley, were included in the assessment.

The evaluation indicates that stability of steelhead spawning gravels is very good in the upper mainstem reach. The potential for scour of Chinook salmon gravels is moderate, but represents an acceptable balance between periodic streambed mobilization and spawning gravel stability. The lower incidence of scour of steelhead gravels compared with Chinook salmon gravels is partially due to the later steelhead incubation period. The incidence of flows that might scour spawning gravels later in the season when steelhead are incubating is fairly low on the upper reach.

In the middle reach of the Russian River at Alexander Valley, spawning gravels are less stable and subject to slightly more frequent scour than the upper reach. The evaluation indicates moderately stable conditions for Chinook salmon, and slightly less stable conditions for steelhead. Higher discharges due to tributary flow accretion probably account for the greater incidence of scour in the middle reach compared with the upper reach. Flood control operations do not have a significant affect on peak flows and spawning gravel scour in the middle reach of the Russian River.

The potential for bank erosion was evaluated for the upper and middle reaches of the Russian River in *Interim Report 1* (ENTRIX, Inc. 2000a). On the mainstem Russian River, 6,000 cfs at Hopland in the upper reach, and 8,000 cfs at Cloverdale in the middle reach were identified as the flow threshold at which bank erosion is likely to begin. The analysis indicates that prolonged flows above these thresholds are relatively infrequent. At Hopland, 80 percent of the 36-year period-of-record received an acceptable score. At Cloverdale, 75 percent of the 36-year period-of-record received an acceptable score. It is noteworthy that on many of the days when flows exceed the erosion threshold at either location, discharge from CVD is low. Flood control operations are often timed so that reservoir outflows during prolonged peak streamflow conditions downstream are a relatively insignificant contributor to total flow and to bank erosion at Hopland or Cloverdale. Thus, evaluation criteria may overestimate the influence of CVD operations on flow and bank erosion. Nevertheless, the evaluation indicates that flood operations at CVD do not cause prolonged flows above the threshold that initiates streambank instability and erosion.

Flood control operations have a minimal effect on channel maintenance/morphologic conditions on the mainstem. The channel-forming discharge was identified in the upper reach as 9,500 cfs at Hopland, and in the middle reach as 14,000 cfs at Cloverdale and 21,000 cfs at Healdsburg. *Interim Report 1* evaluated flood control operations (ENTRIX 2000a). The evaluation indicates that the natural channel maintenance occurs only slightly less often than the estimated “ideal” frequency of one event every two out of three years.

Fish stranding may occur due to ramping down of streamflows during flood control operations at high reservoir releases (250 cfs-1,000 cfs) and at lower reservoir releases (less than 250 cfs). Fry and juveniles are most vulnerable to stranding during ramping due to their poor swimming abilities. However, the potential for stranding is unlikely, given the ramping rates generally used at CVD during flood control operations and the small percentage of the rainfall runoff the CVD controls. Current operational conditions associated with interim ramping rates appear to provide adequate protection to listed species.

During CVD maintenance and inspections, flows are typically ramped down at a rate of 50 cfs per hour until releases cease. Recent historical effects of ramping on the East Fork and mainstem Russian River were evaluated regarding incidences of stranding. Based on this evaluation, current ramping rates do not provide adequate protection from stranding for fry or juveniles of steelhead or Chinook salmon. Coho salmon do not rear in the upper reach of the mainstem Russian River and were not evaluated.

CVD inspections and maintenance at CVD during the fall has resulted in dewatering stream segments in the East Fork and further downstream on the mainstem, creating the need to rescue juvenile steelhead. However, during inspection and maintenance in June 1999, no stranding was documented and fish rescue was unnecessary, as pools were maintained on the East Fork to provide refuge. The presence of pools and lack of stranding may have been partially due to dewatering of the stilling basin, which provided about 1 cfs to 4 cfs for several hours following cessation of releases from the dam. In addition, flow accretion from seepage or groundwater contributions may have also maintained pools and minimal streamflow. Flow downstream of the Forks near Ukiah on the mainstem was at least 14 cfs during the inspection and maintenance activities.

Flow records since 1995 indicate that 35 cfs or more may be expected at the Ukiah gage (USGS gage 11461000) in May, contributing flow to the mainstem below the Forks. During the past five years, streamflow has not been less than 11 cfs at the gage in May. Rearing habitat has not been characterized for the East Fork. However, rearing habitat conditions appear to be fair, based on the monitoring observations in June 1999 and the relatively short period of time (several hours) that flows were reduced.

2.4 LOWER REACH AND DRY CREEK

2.4.1 WARM SPRINGS DAM AND LAKE SONOMA

Lake Sonoma is a multipurpose reservoir. It provides flood protection to areas downstream, provides water for domestic, municipal, and industrial uses, and is operated for hydroelectric power operation (Figure 2-1). It collects runoff from a drainage of approximately 130 square miles.

Lake Sonoma has a gross capacity of 381,000 AF at the spillway crest elevation of 495 feet above MSL. Lake Sonoma has a 130,000 AF flood control storage capacity, which is sufficient to collect runoff from the 100-year, six-day flood event. The conservation pool has a 245,000 AF design capacity. SCWA has a permit for water rights of 245,000 AF of water in Lake Sonoma. As with Lake Mendocino, SCWA determines the rate of release of water from the water supply pool in Lake Sonoma in accordance with its state water rights permit. USACE determines releases when the water level rises above the top of the water supply pool (elevation 451 feet above MSL) and into the flood control pool. USACE determines releases during inspections, maintenance, and repairs for the project scheduled outside of the flood control season. Following formal notification by USACE, SCWA notifies affected regulatory agencies, including FERC and SWRCB, of these lower releases. USACE notifies and consults with NOAA Fisheries.

The WSD and Lake Sonoma Project are operated using the *Warm Springs Dam and Lake Sonoma, Dry Creek, California Water Control Manual* (USACE 1984). Objectives described in this document include: (1) provide the maximum reduction in peak-flood discharges on Dry Creek and the Russian River below Healdsburg; (2) provide the maximum practical amount of conservation storage without impairment to other project functions; and (3) maintain a minimum pool elevation of 292 feet MSL to assure operation of the fish hatchery. The 130,000 AF of flood control storage in Lake Sonoma was designed to provide control of a flood the size of the December 1955 flood.

USACE requires a minimum fishery pool be maintained at an elevation of 292 feet MSL (USACE 1998b). At this minimum pool, the reservoir has a storage volume of 20,000 AF, a surface area of 415 acres, extends approximately five miles up Dry Creek and two miles up Warm Springs Creek, and has 17 miles of shoreline (USACE 1998b).

Nearly all conservation releases from Lake Sonoma are used to meet municipal, domestic, and industrial demands in the lower Russian River area and portions of Sonoma and Marin counties (USACE 1998b). To meet these demands, water released from Lake Sonoma combines with releases from CVD and runoff from other tributaries. Inflow to Lake Sonoma approaches zero from July through September, and the reservoir normally reaches its lowest level in November.

2.4.1.1 Flood Control Operations of Warm Springs Dam

USACE's primary objective for flood control operation at WSD is to reduce peak flood discharges in Dry Creek and the Russian River below Healdsburg to the extent possible. Because of the long travel time for water flow between CVD and the Russian River/Dry Creek confluence, flood control operations at WSD are generally independent of the CVD operation; however, operations of the two facilities are coordinated to avoid downstream flooding.

The criteria for flood control operation of Lake Sonoma are similar to those for Lake Mendocino and are described in the WSD Water Control Manual (USACE 1998). Releases from the flood control pool include all reservoir storage above elevation 451.1 feet MSL. As with Lake Mendocino, flood control includes three successive flood release schedules. For Lake Sonoma, the Hacienda Bridge gage, located 16 miles downstream of WSD, is the most downstream monitoring point for decisions affecting flood control releases from Lake Sonoma.

To the extent possible, USACE limits releases from Lake Sonoma to restrict flows on the Russian River at Guerneville to 35,000 cfs, which is the approximate channel capacity in Guerneville. USACE also limits releases to prevent flooding downstream along Dry Creek, which generally occurs when flows just below the dam exceed 6,000 cfs. As with releases from Lake Mendocino, USACE limits changes in releases to 1,000 cfs per hour to prevent downstream bank sloughing.

More specific directions are included in Exhibit A to the WSD Water Control Manual (USACE 1998b), titled "Standing Instructions to Damtenders" (WSD Standing Instructions). Operation for flood control is described in the Flood Control Diagram that is summarized by Section 9b of the WSD Standing Instructions:

> *Flood Control Schedule 1, 2, and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow in the Russian River near Guerneville to exceed 35,000 cfs, and (2) the discharge that*

results in flow at Guerneville being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the event(s), which caused the highest pool at Lake Sonoma. In addition, releases will be limited to a maximum of: (1) 2,000 cfs if the reservoir pool did not reach elevation 456.7 feet, (2) 4,000 cfs if the highest reservoir pool reached was between elevation 456.7 feet and 468.9 feet, and (3) 6,000 cfs if the pool exceeded elevation 468.9 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. When the pool elevation is at or below 502.0 feet and inflow is at or above 5,000 cfs no gate releases will be made. Schedules 1, 2, and 3 are used only if no significant rainfall is forecasted.

Significant rain is forecasted when the QPF is 1 inch or more for the next 24 hours or ½ inch or more for any 6-hour period in the next 24 hours. Under this condition, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to the minimum required flow within 1½ hours if necessary. The 1½ hours includes time to travel to the control tower and make the first gate change.

Flood Control Schedule 3 releases will be maintained until elevation 502.0 feet is reached by regulation of the outlet so that the combined flow from spills (pool above elevation 495.0 feet) and releases through the outlet works does not exceed 6,000 cfs.

The Emergency Release Schedule is used when the pool elevation is between 502.0 feet to 505.0 feet. At elevation 505 feet and above, the flood control gates will be fully opened. The flood control gates will remain fully open until the lake has receded below elevation 505 feet, at which time the Emergency Release Schedule is again implemented. When the lake has receded below elevation 502.0 feet, Flood Control Schedule 3 is implemented.

The allowable water conservation storage in Lake Sonoma remains constant throughout the year. Because of the configuration of the watershed above Lake Sonoma, direct measurement of reservoir inflow by stream gaging is impractical. Consequently, inflow is calculated as the algebraic sum of releases, changes in storage, and the estimated evaporation.

Water is released from WSD for flood control purposes through the outlet works or through the spillway, which are located on the left abutment of the dam. The control structure accommodates multiple intakes designed for municipal and industrial uses, as well as for meeting water quality requirements. Maximum discharge capacity of the outlet works is 8,100 cfs when the reservoir pool is at 513.1 feet MSL. The spillway was designed for a discharge of 29,600 cfs, with the maximum reservoir pool elevation level 18 feet above the spillway crest.

2.4.1.2 Water Supply Operations

The Russian River from Healdsburg to its mouth at Jenner operates in much the same manner as the Russian River above Healdsburg. In the summer, water from Lake Sonoma storage is released for rediversion by the SCWA water transmission system and to meet D1610 instream flow requirements. Flow regulation in this reach is described in Section 2.5.

The primary concern regarding the quality of water released from WSD arises from its use in the DCFH. This water passes through the hydroelectric facility before it reaches the hatchery. *Interim Report 2: Fish Facility Operations* (FishPro and ENTRIX, Inc. 2000) has additional information on historic water use of the DCFH. Water quality (including turbidity, suspended sediment concentrations, temperature, and DO) has been monitored at DCFH twice every month for as long as it has been in operation.

The water quality of the outflow from the dam, including temperature, DO, and turbidity, is managed by mixing water from two of the three low-flow tunnels that draw water from different levels of Lake Sonoma. The selection of water intake levels from WSD is determined by USACE in coordination with CDFG to meet the water quality needs of the DCFH. This controls the water quality of releases to Dry Creek as well. Turbidity levels in the deeper levels of the lake are too high to be used in the hatchery. Prior to 2002, the portal nearest to the lake's surface was out of service and could not be used. Only the two intermediate portals have been typically used to provide water for the DCFH and for downstream releases. USACE data for dam outlet temperatures for WSD from January through November 1999 demonstrate the ability to draw water from deeper, cooler depths of Lake Sonoma, which keep the outlet temperatures cooler during summer months.

Seasonal temperature requirements of water delivered to the fish facility range from 52°F to 55°F (11.1^{o}C to 12.8^{o} C) from October through April, and 55°F to 58°F (12.7°C to 14.4°C) from May to September. It is estimated that only during a year of maximum drawdown, or about once in 50 years, will the reservoir be unable to provide water that meets hatchery temperature requirements (USACE 1998b).

2.4.1.3 Warm Springs Dam Hydroelectric Facility

The WSD hydroelectric facility is owned and operated by SCWA. The hydroelectric facility was completed in December 1988 at a total cost of $5 million. SCWA operates the facility under a 50-year license issued by FERC on December 18, 1984 (Project No. 3351-002). The WSD hydroelectric facility's generator is a 3,000 kilowatt (KW) Francis Turbine, and has a power rating of 2.6 MW (USACE 1984). The facility is located within the control structure of the outlet works for WSD.

Water from Lake Sonoma flows to the hydraulic turbine via a vertical wet-well located in the control structure that draws water from the horizontal, low-flow tunnels. The upper tunnel was nonoperational but was repaired in 2002. Water from the tunnels drops between 132 and 221 feet to the turbine. Water passing through the turbine flows into the flood control tunnel to a stilling basin located at the base of the dam. A 20-inch bypass line installed inside the conduit provides water to the hatchery in the event of a gate failure. This bypass line can divert water through the hatchery and to Dry Creek at a maximum flow capacity of about 30 cfs.

From the stilling basin, water flows through a channelized portion of Dry Creek, or is diverted for use in the DCFH adjacent to WSD. The stilling basin is a concrete-lined basin at the mouth of the outlet tunnel. A two-step weir, approximately 18-feet high, is used to reduce the water velocity from the outlet tunnel and to keep fish that are downstream of the dam from entering the outlet tunnel.

The WSD hydroelectric facility operates during normal releases of storage water through the low-flow tunnels and the wet well. A minimum flow of approximately 70 cfs is needed to operate the turbine. The maximum flow capacity for the WSD turbine is 175 cfs. During flood control operations (when releases from WSD exceed 3,000 cfs), flow through the wet well and turbine are shut off to prevent hydraulically unstable conditions from developing in the outlet piping. When water releases of more than 500 cfs are required, service gates in the intake conduit beneath the dam are opened and flows bypass the wet well and turbine. The minimum opening allowed for the service gates is 1-foot, which relates to a release of 500 cfs. Also, flows of 185 cfs through the turbine can continue, with the remaining flow bypassed through the service gates. However, the total flow through the wet well and the service gate must be less than 3,000 cfs.

Flows through the WSD hydroelectric facility are determined by water supply needs and minimum instream flow requirements. The water supply needs and minimum instream flow requirements set by D1610 (SWRCB 1986a) are greater than the flows needed to meet the minimum power generation requirements. Therefore, generation needs currently do not control release rates.

The Russian River system model, developed by SCWA, models flow in the Russian River basin based on minimum streamflow requirements (under D1610) and water supply demands (Flugum 1996). The model calculates the amount of power generated at model flows. Table 2-13 shows the power generated at model flows for June, July, and August for 1988 through 1995. These years encompass both *normal* and *dry* water supply conditions. All of the modeled power values exceed the minimum 1.246 MW. Therefore, hydroelectric operations at WSD do not control flow.

Articles 33 and 34 of SCWA’s FERC license (FERC 1984) contain minimum release provisions for WSD that are identical to the D1610 minimum flows.[6] Article 34 also specifies that SCWA must, “operate the Warm Springs Project such that the water surface elevation of Lake Sonoma fluctuates no more than two vertical feet between April 1 and June 15 of each year.”

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[6]Details on water supply and minimum streamflow needs are addressed in *Interim Report 3: Flow-Related Habitat* and *Interim Report 4: Water Supply and Diversion Facilities* (ENTRIX, Inc. 2002a, 2001a).

Table 2-13 Power Generated at Russian River Model Flows under Decision 1610

Water Year	Power (MW)
1988	2.427
1989	2.750
1990	1.382
1991	1.594
1992	4.129
1993	3.437
1994	1.606
1995	3.721

The wording of Article 34 initially presented some uncertainty as to how the WSD hydroelectric facility was to be operated under the license. This is because other operating requirements, such as D1610[7] minimum streamflows and USACE flood control release criteria (USACE 1984, 1986a) require changing the surface elevation of Lake Sonoma by more than two vertical feet between April 1 and June 15. During the license application process, SCWA and CDFG agreed that water should not be released solely for electrical power production purposes when such releases would contribute to or cause surface fluctuations in Lake Sonoma to exceed two vertical feet per month between April 1 and June 15. The recitals in FERC’s 1984 order stated FERC's intention to incorporate this agreement into the license without modification. SCWA's interpretation of Article 34 is that surface water fluctuations resulting from releases solely for the purpose of power production between April 1 and June 15 are limited to two vertical feet per month, as agreed by SCWA and CDFG, and as intended in the FERC order. In a letter dated June 2, 1989, SCWA notified FERC of its interpretation. FERC has taken no exception to this interpretation.

Because intakes to the WSD hydroelectric facilities are not screened, resident salmonids from Lake Sonoma could pass through the tunnels and into the turbines. Although the exact number of fish passing through the WSD hydroelectric facility’s turbine is not known, it is expected that mortality occurs to fish passing through the turbine due to injuries either from mechanical blows or excessive pressure. To mitigate for potential fish losses from Lake Sonoma, additional enhancement measures were taken to improve the fishery of the upper Russian River, including expansion of the DCFH at WSD and construction of a fish facility at CVD.

No instream work is necessary to maintain the WSD hydroelectric facility. All maintenance activities occur within the WSD control structure shaft. During any unplanned events that require shutting down the generator, automatic controls shut down flows to the turbine and open a valve that bypasses flows around the turbine unit.

[7]Decision 1610 was prepared by SWRCB in April 1986 and amends the terms and conditions of water use permits held by SCWA.

2.4.2 FACTORS AFFECTING SPECIES ENVIRONMENT WITHIN THE LOWER RUSSIAN RIVER

2.4.2.1 Flood Control

On Dry Creek, effects of flood control operations on listed fish species were evaluated in *Interim Report 1* for coho salmon, steelhead, and Chinook salmon (ENTRIX, Inc. 2000a). The analysis indicates that there is a reasonably good balance between expected periodic streambed mobilization and spawning gravel stability for successful reproduction of these species. Coho salmon, utilizing smaller gravels for spawning, would be subject to a greater frequency of scour than either Chinook salmon or steelhead redds in Dry Creek. Some mobilization and scour of spawning gravels to transport and remove fine sediments is necessary over the long-term to maintain the quality of spawning gravels.

Bank Erosion

On Dry Creek, sustained flows above 2,500 cfs can initiate bank erosion. The bank erosion analysis was performed at two locations, immediately below WSD and downstream of the most significant tributary confluence at Pena Creek (the “Near Geyserville” location). The Near Geyserville location is below the Pena Creek confluence and above the Yoakim Bridge. Overall, the analysis indicates that the potential for bank erosion is relatively low in most years (ENTRIX, Inc. 2000a). Inspection of the streamflow gaging records indicates that on many days when flows exceeded the erosion threshold at the Near Geyserville location, discharge from WSD was low. Similar to CVD operations, the flood control operations at WSD are often timed so that reservoir outflows during prolonged peak streamflow conditions downstream are a relatively insignificant contributor to total flow and therefore to bank erosion. The analysis indicates that flood operations at WSD are not a significant factor contributing to prolonged flows above the threshold that initiates streambank instability and erosion in most years.

Channel Geomorphology

The change in hydrologic regime associated with flow regulation by dams has influenced channel geomorphic response. The type and magnitude of adjustments depends on initial channel conditions and the extent of changes in discharge and sediment supply. The effect of dams on the morphology of a river tends to diminish downstream due to discharge and sediment contributions from tributaries. Although the rate of channel change in response to flow regulation by dams is highly variable, most channel adjustments likely take place within a few decades following dam construction (Mount 1995).

Flow regulation at WSD has reduced the magnitude of peak-flood discharges in Dry Creek. In response, river channels typically modify their cross-sections by channel narrowing due to sediment deposition and encroachment by riparian vegetation. When the bed material is a sand and gravel mixture as on Dry Creek, channel incision will often accompany channel narrowing if the flood peaks are of sufficient magnitude to mobilize most of the bed materials. Excessive channel incision often results in over-steepened streambanks and subsequent erosion. If flood peaks are sufficiently reduced under flow regulation, then the coarser bed material will not be entrained, and only finer material will be transported, leading to an overall coarsening of the channel bed. However, if flood peaks are substantially reduced so that there is little or no transport of coarse sediments, the channel response is likely to be aggradation. Coarse sediment supplied by local tributary input will exceed competence and lead to channel aggradation.

If flow regulation sufficiently reduces peak flood events so that the sediment transport regime is altered and coarsening of the channel bed or aggradation results, then fish habitat conditions may be negatively affected. Spawning gravels may be subject to accelerated rates of fine sediment intrusion, decreasing reproductive success. Increased sediment deposition in riffles may reduce benthic macroinvertebrate production, decreasing the available food base. Rearing habitat may also be affected due to sediment deposition in pools.

Channel geomorphic changes may also occur due to interruption of the sediment transport regime by dams and reservoirs. If coarse sediments are deposited within a reservoir, removing a significant portion of the total sediment load, then replenishment of sediments downstream will be reduced until there are sufficient sources of sediment input from downstream tributaries. This can lead to excess stream power immediately downstream of a dam. Relatively clear water with little sediment in transport can perform more work scouring sediments from the streambed, banks, and floodplain. Thus, entrainment of fine sediments below the reservoir may continue. Without sediment replenishment and with excess stream power, only the coarsest material may be left behind, leading to armoring of the channel bed.

It is recognized that adequate flows are periodically needed to maintain channel geomorphic conditions by mobilizing the streambed and transporting sediments. Such flows are necessary to provide suitable spawning and rearing conditions for salmonids, flushing fine sediments from the streambed. However, if flood releases are of sufficient magnitude and frequency to regularly scour redds, spawning may be adversely affected. Ideally, there is a balance, or dynamic equilibrium, between periodic mobilization of the streambed, transport of sediment, and sediment deposition and stability of spawning gravels. Lack of peak flows can reduce spawning success, as can an increase in the frequency and magnitude of peak flows.

Gravel Mining

The alteration of the flow regime associated with dams is not the only cause of changes in channel morphology. Development in the Russian River watershed, including gravel extraction, agricultural practices, and urbanization, also influence channel geomorphic conditions. Land-uses that significantly increase or decrease (as in the case of gravel mining) sediment supply will cause as pronounced alterations in channel geomorphology as flood regulation by dams. Distinguishing the effects of flood-control operations from these land-use effects on channel conditions can be problematic.

Significant channel geomorphic changes were apparently already underway on Dry Creek prior to the construction of WSD. A study conducted by USACE concluded that gravel mining on Dry Creek and on the mainstem Russian River had caused about 10 feet of incision along the 14-mile channel length by the mid-1970s (USACE 1987). The channel incision on Dry Creek initiated lateral instability and subsequent bank erosion so that channel width had increased from about 90 feet to over 450 feet in some locations in the 1970s (USACE 1987). The 1987 study concluded that it was unlikely that further channel degradation would occur, but that continued lateral instability and erosion of the incised channel banks was likely.

2.4.2.2 Stranding/Ramping

Annual and periodic pre-flood inspections are performed at WSD. Flows may be reduced in order to perform periodic maintenance activities on the dam. Since there is a bypass flow capability at WSD, stream dewatering is unlikely and has not occurred under recent operational practices. The bypass streamflow is generally between 25 cfs and 28 cfs. Ramping during pre-flood inspection and maintenance activities using a 25 cfs/hr ramping rate provides adequate protection against stranding of listed species in Dry Creek.

2.5 WATER SUPPLY OPERATIONS AND FLOW

2.5.1 WATER SUPPLY OPERATIONS

SCWA is the wholesale provider of potable water for approximately 570,000 people in Sonoma and Marin counties. Since its creation in 1949, SCWA's role as a water supplier has evolved into two primary responsibilities:

> *Operation of the Russian River Project*: As the local sponsor for the two federal water supply/flood control reservoir projects in the Russian River watershed (CVD/Lake Mendocino and WSD/Lake Sonoma), SCWA, under operational agreements with the USACE, manages the water supply storage space in these reservoirs to optimize the water supply yield of the system and maintain flows in the Russian River and Dry Creek. SCWA holds water rights permits to divert Russian River and Dry Creek flows and redivert water stored and released from these water supply reservoirs.
>
> Among the provisions contained in SCWA's water rights permits are terms authorizing rates of direct diversion and rediversion. The proportions of water diverted and rediverted in any water year vary widely and depend on the amount of runoff and water demand.
>
> *Operation of the water transmission system*: Downstream of Lake Mendocino and Lake Sonoma, SCWA diverts and delivers water to its wholesale customers through its water transmission system. This system consists of diversion facilities, treatment facilities, pipelines, water storage tanks, booster pump stations, and groundwater wells.

SCWA is responsible for the operation of the water transmission system through an existing water supply agreement between SCWA and eight cities and water districts in Sonoma County and northern Marin County (see Section 1.4.8), collectively referred to as the water contractors. This agreement, titled "Eleventh Amended Agreement for Water Supply" (Eleventh Amended Agreement, SCWA 2001a), executed in 2001, provides the authority for the finance, construction, and operation of diversion facilities, transmission lines, storage tanks, booster pumps, conventional wells, and any appurtenant facilities. These facilities presently can meet peak-month deliveries at an average of 149 mgd. In addition, the Eleventh Amended Agreement authorizes SCWA to provide 20 mgd of pump and collector standby pump and collector capacity, which allows SCWA to meet currently authorized water deliveries during periods when existing facilities are out of service (i.e., routine maintenance, equipment failure, system failures caused by earthquakes, floods, power outages, or other emergencies).

In addition to the Eleventh Amended Agreement, SCWA has agreements with the City of Healdsburg, the Town of Windsor, the Russian River County Water District, Camp Meeker Recreation and Park District, and Occidental Community Services District allowing those entities to divert water from the Russian River under SCWA-held water rights. The analysis presented in *Interim Report 4* addressed the effects on listed fish species of operation of the water supply and transmission system under existing water rights held by SCWA (ENTRIX, Inc. 2001a).

2.5.2 Flows Under D1610

Lake Sonoma and Lake Mendocino are currently operated in accordance with criteria established by D1610. D1610 adopted, with one minor change, the criteria included in an agreement between CDFG and SCWA that established flow requirements for Dry Creek and the Russian River (SCWA and CDFG 1984). Minimum streamflows under D1610 are specified for four different reaches in the Russian River watershed: the East Fork Russian River from CVD to the confluence with the mainstem, the mainstem Russian River between the East Fork Confluence and Dry Creek, the mainstem Russian River between Dry Creek and the mouth, and Dry Creek downstream of WSD to the confluence with the Russian River. D1610 represents the baseline minimum instream flow conditions evaluated in the BA.

Under D1610, minimum flows in both the upper and lower Russian River vary depending upon water supply condition. Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as *critically dry*, *dry*, or *normal*. The water supply condition can vary from month to month until June 1 when it becomes stable until the following January. Within the *normal* water supply condition, minimum flow criteria for Lake Mendocino releases, there is a separate schedule referred to as the *dry spring* criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. These criteria allow successive reductions in minimum flows for the mainstem Russian River when the combined storage falls below 90 percent and 80 percent of the combined capacities of Lake Pillsbury and Lake Mendocino. This provision reflects the importance of the storage space in Lake Pillsbury and the storage space within the flood pool of Lake Mendocino in sustaining the flows in the Russian River system, and the fact that this storage space cannot be fully utilized in *dry spring* conditions. Historically, in about 11 percent of years, *dry spring* water supply conditions prevail from June through December. *Dry spring* conditions do not apply to the January through May period.

Figure 2-7 summarizes the minimum flow requirements contained in D1610. In the Russian River system, minimum flow rates are required to be maintained throughout entire reaches of the river, rather than at specified points. In the Russian River between Lake Mendocino and Healdsburg, separate minimum flow requirements prevail in the short reach between Lake Mendocino and the mainstem Russian River, and in the mainstem between the confluence of the East Fork and Dry Creek. The point on the river with the lowest flow, referred to as the controlling point, determines the reservoir release. The location of the controlling point changes during the year. In the winter, when flows are increasing downstream, the controlling point is just below CVD. In the summer, when tributary inflows have receded and flows are reduced by diversions, the controlling point is the Healdsburg gage. The transition from upstream to downstream control usually occurs during a period of one to three weeks in May or June, depending on the amount of spring rainfall. D1610 sets separate minimum instream flow requirements for the lower Russian River below Healdsburg and for Dry Creek.

The flow requirements for the Russian River from Lake Mendocino to the Dry Creek confluence in D1610 were based in part upon an evaluation of fish habitat and barriers to fish migration performed by Winzler and Kelly Consulting Engineers (1978) under a contract with USACE. These flow requirements were intended to maintain the highest sustainable flows possible to support the steelhead and salmon fishery below CVD and instream recreation (SWRCB 1986b). The flow requirements were set with the assumption that the water supply available from Lake Mendocino would be sufficient to satisfy flow needs between Lake Mendocino and Dry Creek, and expected diversions along this reach of the Russian River. The minimum summer flow requirements for this reach were established to avoid dewatering Lake Mendocino while providing flows for the recreational canoeing industry.

The instream flow requirements for the Russian River downstream from its confluence with Dry Creek during *normal* water supply conditions were based primarily on a desire to maintain flows upon which the recreational canoeing industry on the Russian River had previously developed. The reduced instream flow requirements for *dry* and *critically dry* water supply conditions were determined in consideration of warmwater fish and wildlife needs, particularly for the lower portion of the Russian River.

The flow requirements for Dry Creek were based on the CDFG instream flow needs investigation performed in 1975 and 1976 (Barraco 1977). These requirements were developed to meet the fish spawning, passage, and rearing needs as determined by CDFG at that time. These flows were to sustain the native fish populations below WSD, to enhance steelhead and salmon spawning and nursery habitat in Dry Creek, and to facilitate operations of the DCFH at WSD.

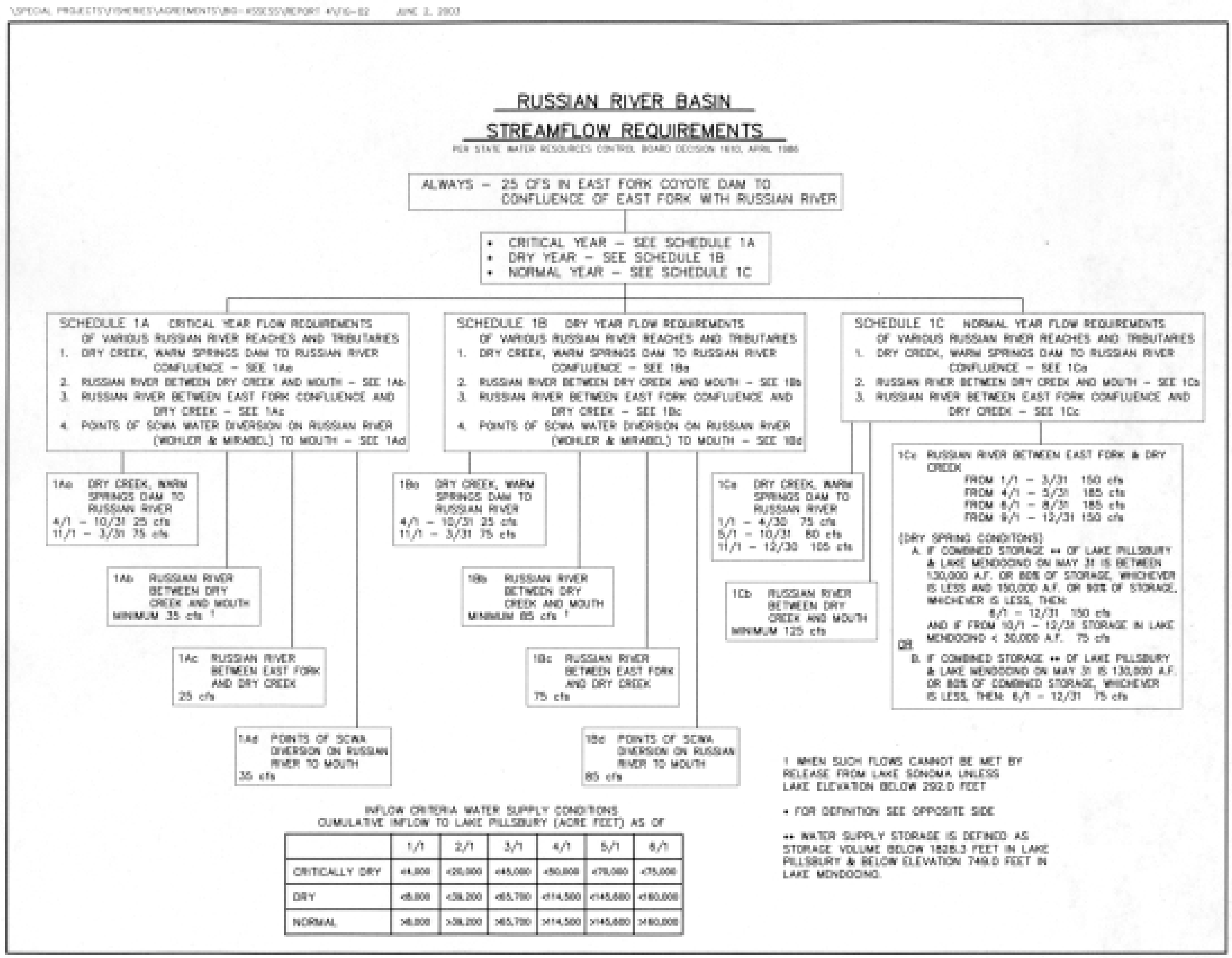

Figure 2-7 D1610 Russian River Basin Streamflow Requirements

Flows in the Russian River from Healdsburg to its mouth at Jenner are managed in much the same manner as the Russian River above Healdsburg. The general operating rule for Lake Sonoma water supply releases is to discharge water needed to satisfy demands (mostly SCWA's) between Dry Creek and the Hacienda gage, and meet the minimum flow requirement at Hacienda. Under current demands, during normal summer conditions, releases from Lake Sonoma are typically controlled by the required minimum flows in Dry Creek and the Russian River.

SCWA has modeled D1610 flow and water temperature using the Russian River System Model (RRSM, Flugum 1996) and the Russian River Water Quality Model (RRWQM) (RMA 2001). These models were used to simulate the flow and water quality conditions that would exist under current and projected future (buildout) water demand conditions. Flow was modeled for each of four locations on the upper (Ukiah), middle (Cloverdale and Healdsburg), and lower (Hacienda) Russian River and on Dry Creek (Figure 2-8).

The upper Russian River is represented by the Ukiah node within the model. The middle Russian River is represented by Cloverdale and Healdsburg nodes. The lower Russian River is represented by the Hacienda node which also estimates inflow to the Estuary. Dry Creek is represented by nodes below WSD and above the mouth.

The current flow regime under D1610 ranges from high flows during the winter months, November through June, and lower flows during the summer months, July through October. The mean daily flows that were equaled or exceeded 50 percent of the time (50 percent exceedance flows) generated by the RRSM are presented in Figures 2-9 through 2-12 for four locations in the Russian River and in Figure 2-13 for Dry Creek. Modeled flows are presented for *all* water supply conditions combined and for *dry* water supply conditions. *All* water conditions represents the full 90-year period (1910 to 2000) simulated in the RRSM including *dry* and *critically-dry* water supply conditions.

During the winter months, the USACE controls releases from CVD and WSD to provide flood protection to downstream areas. In doing so, the USACE captures high flows during high runoff events and releases these flows at a lower magnitude over a longer period of time. The two dams control a relatively small proportion of the watershed, so flows are largely governed by local runoff from unregulated tributary streams. Winter flow levels are typically much higher than summer flow levels.

2.5.2.1 Winter Flows, Russian River

During the winter months flows increase with distance downstream from CVD due to inflows from unregulated tributaries. January through April median flows at Cloverdale range from 831 to 1,404 cfs for *all* water supply conditions and from 263 to 778 cfs for *dry* water supply conditions. At Healdsburg corresponding flows are about 1,200 to 2,200 cfs for *all* water supply conditions and 450 to 1,200 cfs in *dry* water supply conditions, and at the Hacienda Bridge these flows are 1,800 to 3,900 cfs for *all* water supply conditions and 600 to 1,800 for *dry* water supply conditions.

2.5.2.2 Winter Flows, Dry Creek

In Dry Creek, winter flows below WSD range from 76 to 278 cfs from January through April for *all* water supply conditions. In *dry* water supply conditions, median flows during these months are typically about 76 cfs.

2.5.2.3 Summer Flows, Russian River

Modeled summer flows in the Russian River are typically less variable than those during the winter due to the absence of major storm systems in summer. August through November median flows at Ukiah are 167 to 231 cfs for *all* water supply conditions and 106 to 119 cfs in *dry* water supply conditions. The flows at Cloverdale, Healdsburg and Hacienda Bridge are generally quite similar to those at Ukiah for *all* water supply conditions, but decrease slightly (relative to flows at Ukiah) to 90 to 100 cfs during *dry* water supply conditions.

2.5.2.4 Summer Flows, Dry Creek

During the summer months, flows at the mouth of Dry Creek are lower than immediately below WSD. By November, at the onset of the rainy season, they are typically higher. August through November median flows in Dry Creek below WSD are typically 81 to 106 cfs for *all* water supply conditions and from 76 to 127 cfs in *dry* water supply conditions. Median flows in Dry Creek immediately upstream of the confluence with the Russian River are 87 to 111 for *all* water supply conditions and 79 to 121 for *dry* water supply conditions.

2.5.2.5 Water Temperatures

Temperature conditions were modeled using the RRWQM (RMA 2001) based on the flow modeling output of the RRSM for D1610. The development and calibration of the RRWQM are discussed in RMA (2001). Based on the output of this model, temperature conditions in the Russian River and Dry Creek would generally be within a good range for salmonids from November through April, but would be stressful for salmonids in some areas during the summer months, especially in July and August.

Russian River

Figures 2-14 through 2-17 show water temperatures at several modeled stations. Median daily water temperatures in the Russian River near Ukiah remain below 20ºC. At Healdsburg and Hacienda, median water temperatures in August are slightly warmer than 20ºC. At Healdsburg and Hacienda, median water temperatures exceed 23ºC during July and August. Figures 2-18 and 2-19 show the longitudinal profile of modeled water temperatures for the Russian River in July and September, indicating the extent of warming during the warmest times of year. Water temperatures increase in a downstream direction until cold water flows into the river from Dry Creek. This inflow lowers water temperatures for some distance, but the water rapidly warms to its original temperature as it flows downstream below Dry Creek.

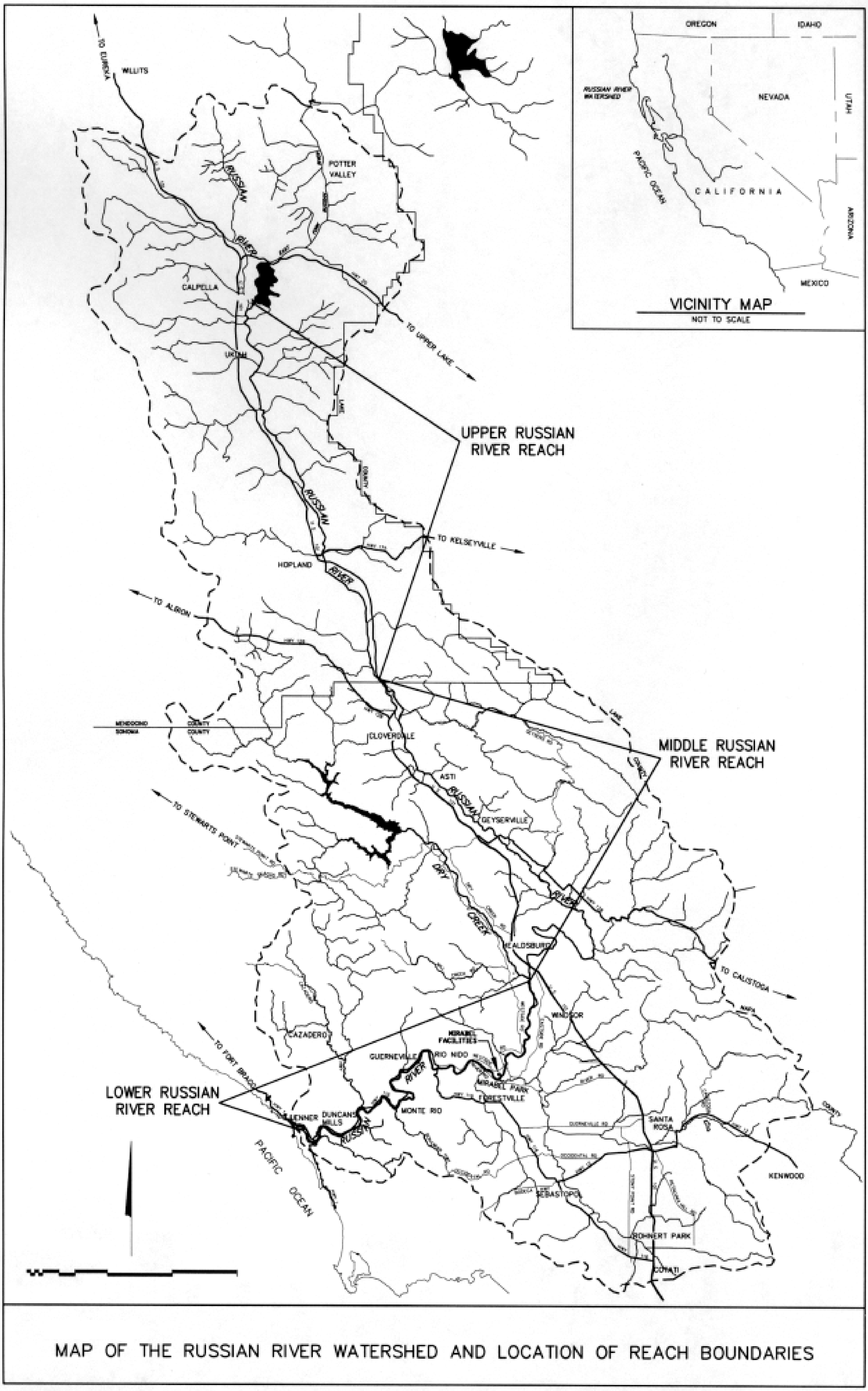

Figure 2-8 Russian River Watershed and Location of Reach Boundaries

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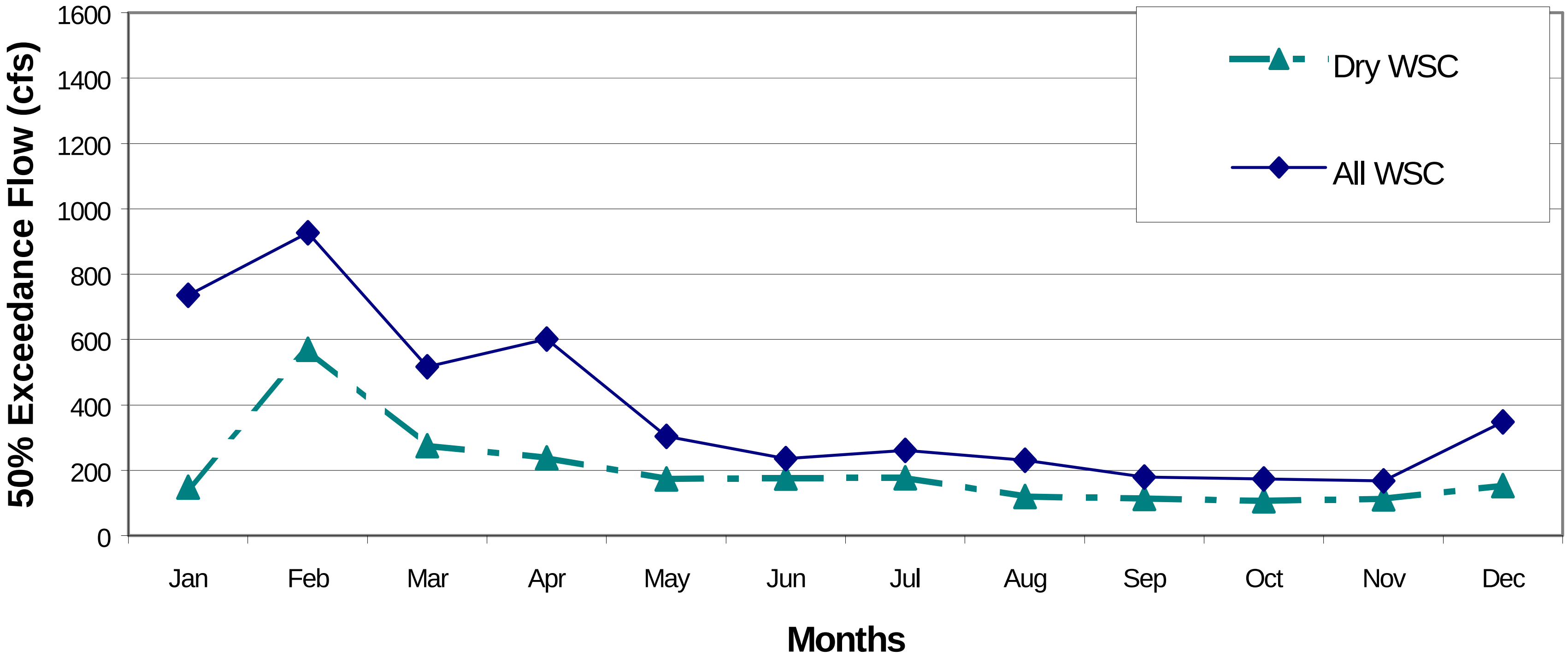

Figure 2-9 Median Flows in the Russian River at Ukiah under D1610 Current Demand Scenario

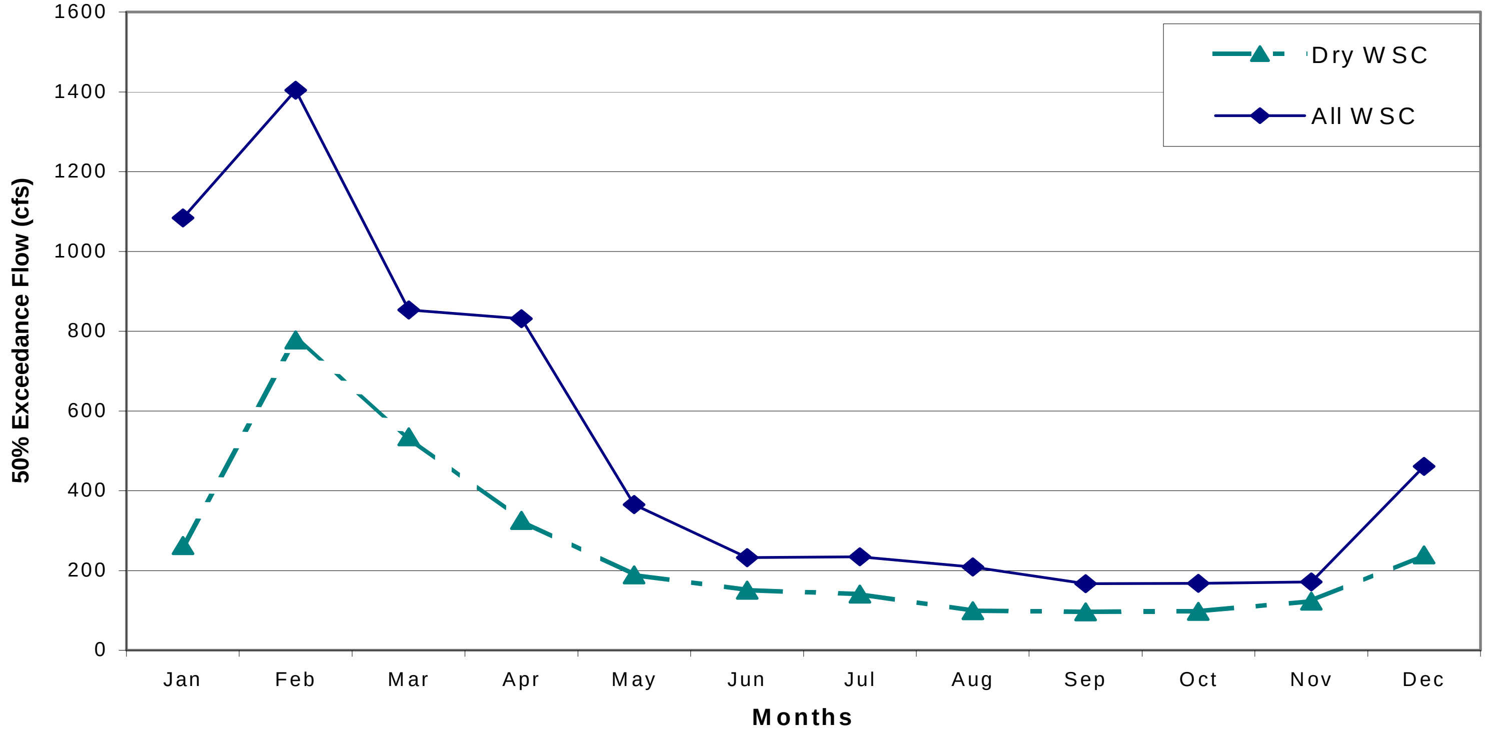

Figure 2-10 Median Flows in the Russian River at Cloverdale under D1610 Current Demand Scenario

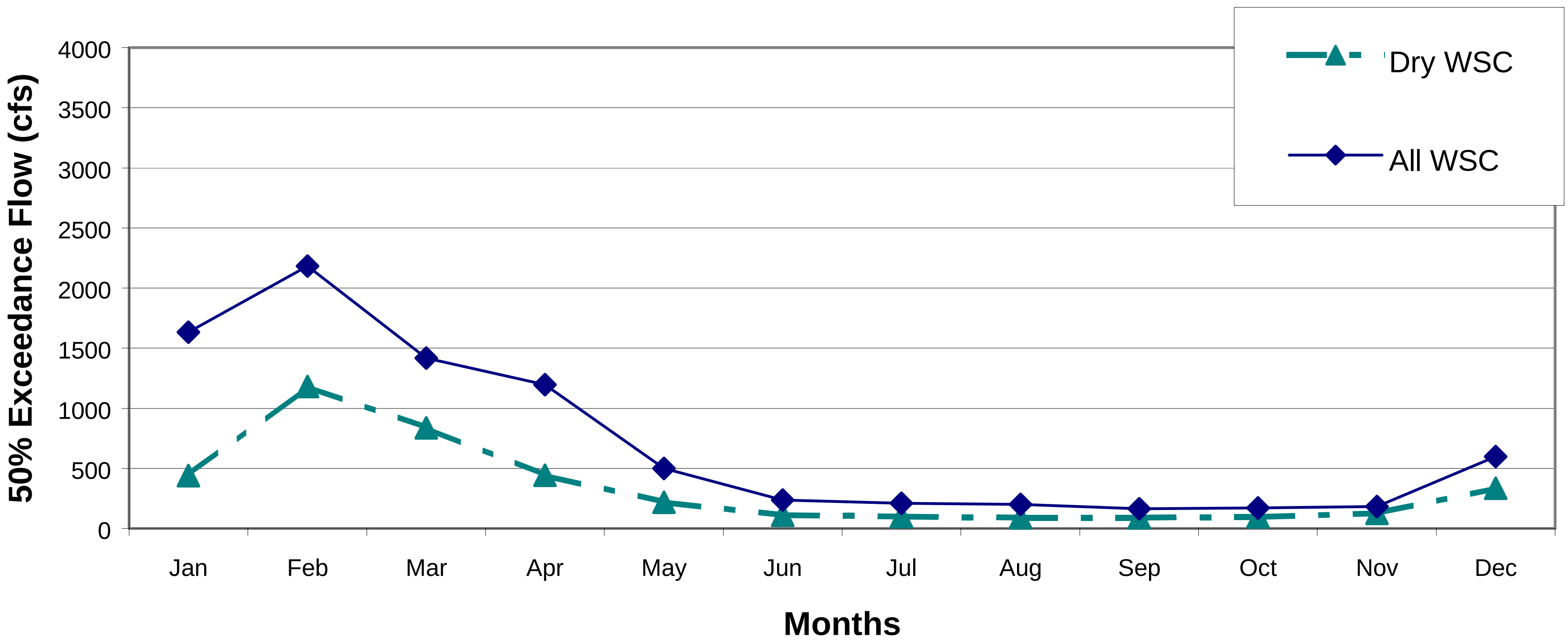

Figure 2-11 Median Flows in the Russian River at Healdsburg under D1610 Current Demand Scenario

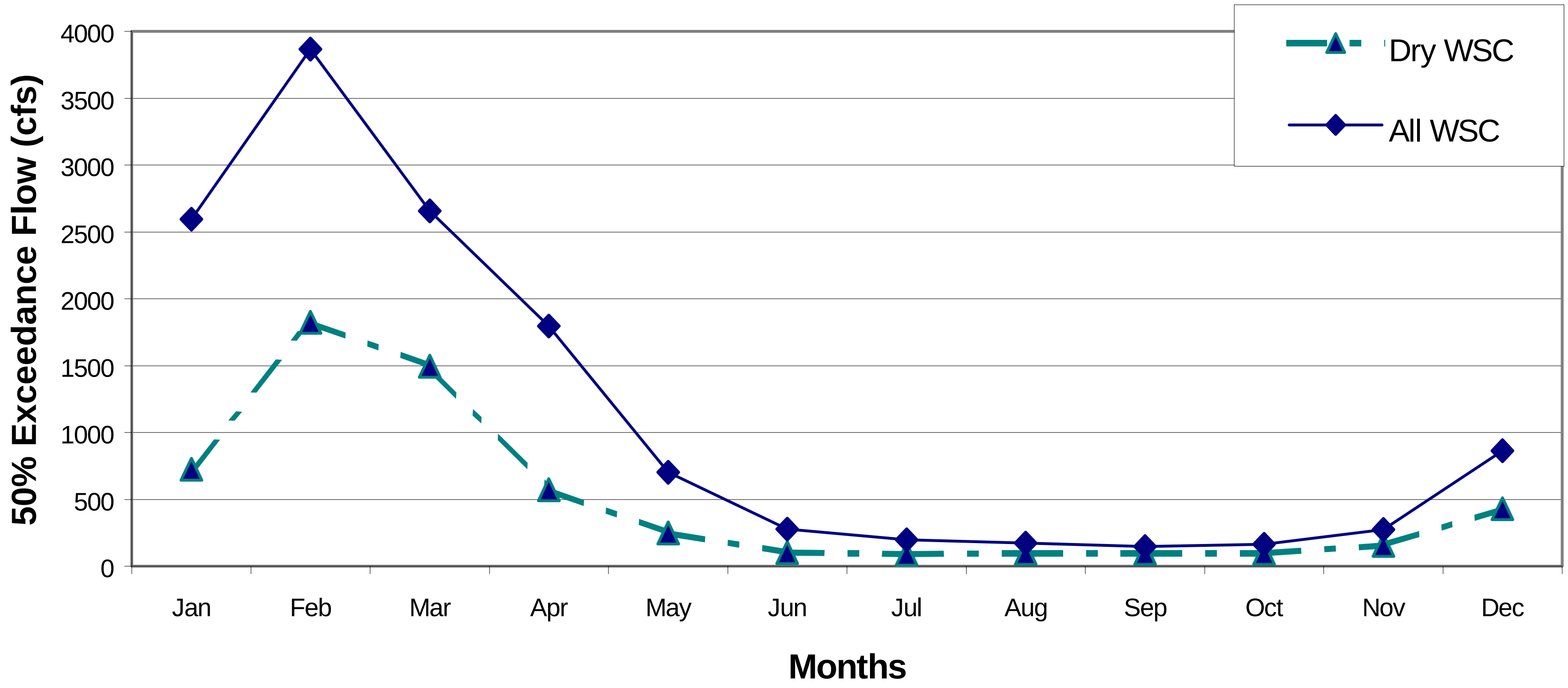

Figure 2-12 Median Flows in the Russian River at Hacienda Bridge under D1610 Current Demand Scenario

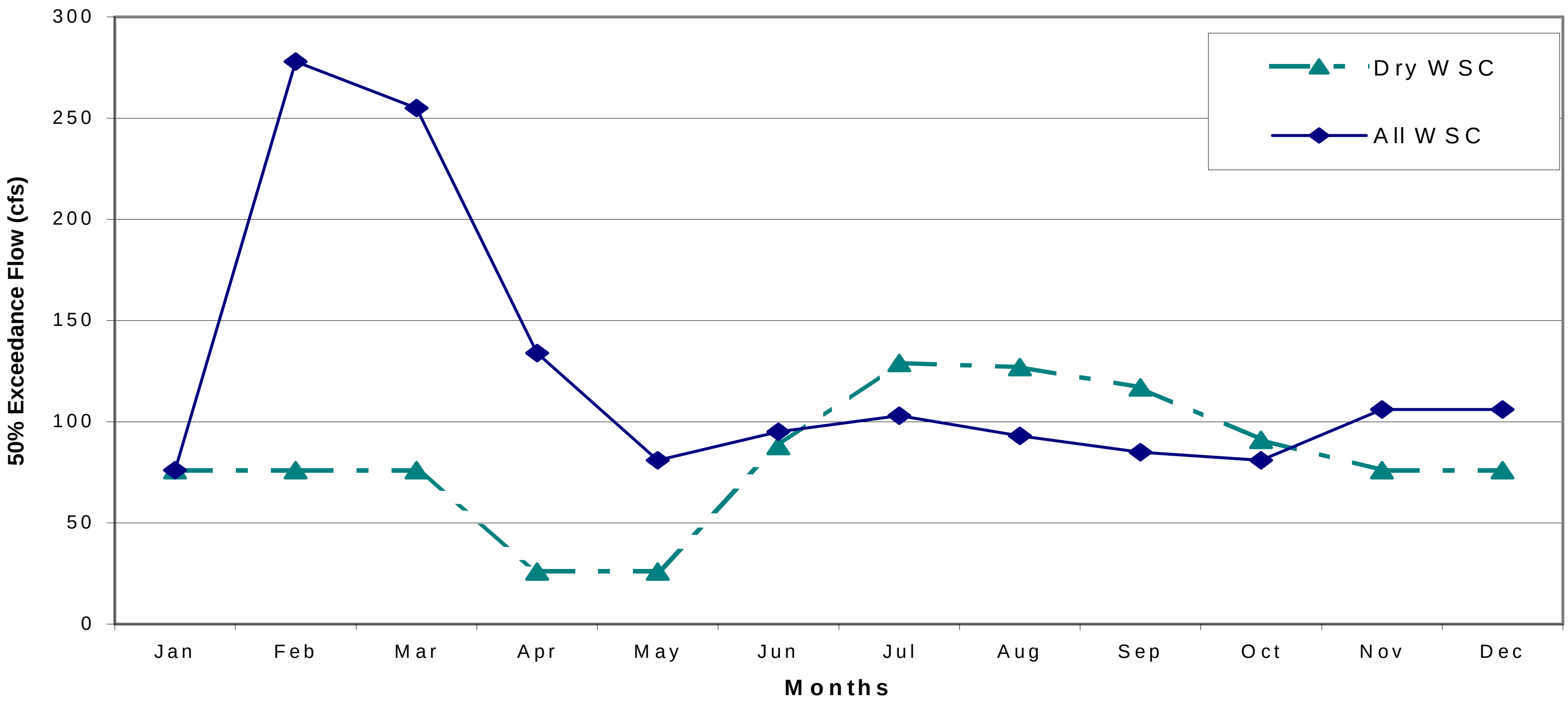

Figure 2-13 Median Flow in Dry Creek below Warm Springs Dam under D1610 Current Demand Scenario

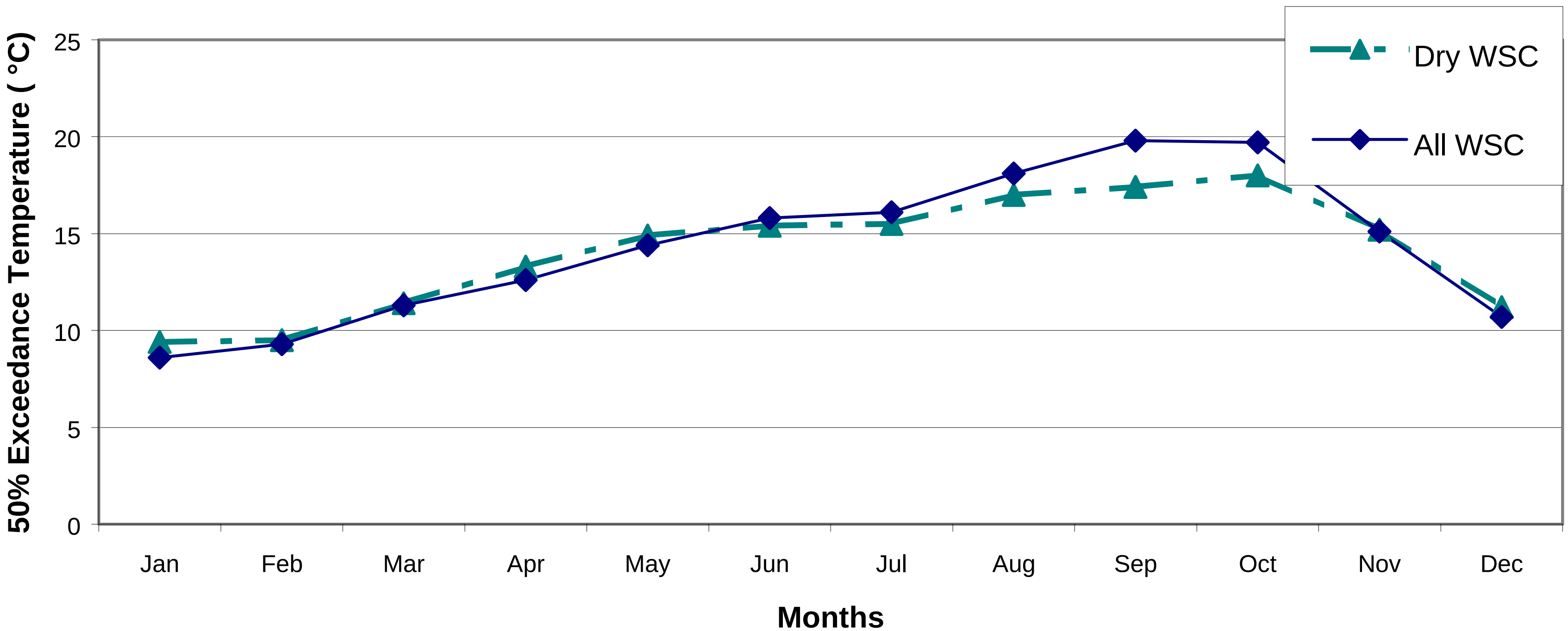

Figure 2-14 Median Daily Temperature in Russian River at Ukiah under D1610

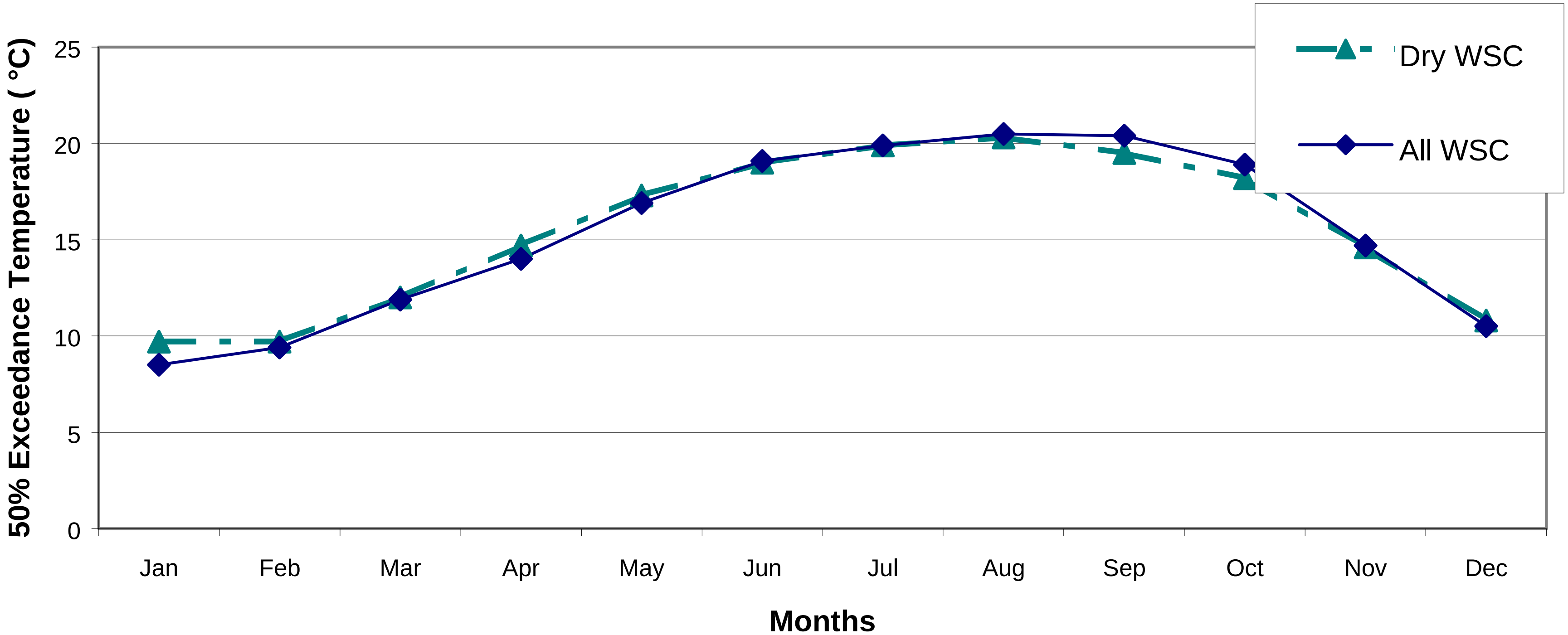

Figure 2-15 Median Daily Temperature in Russian River at Cloverdale under D1610

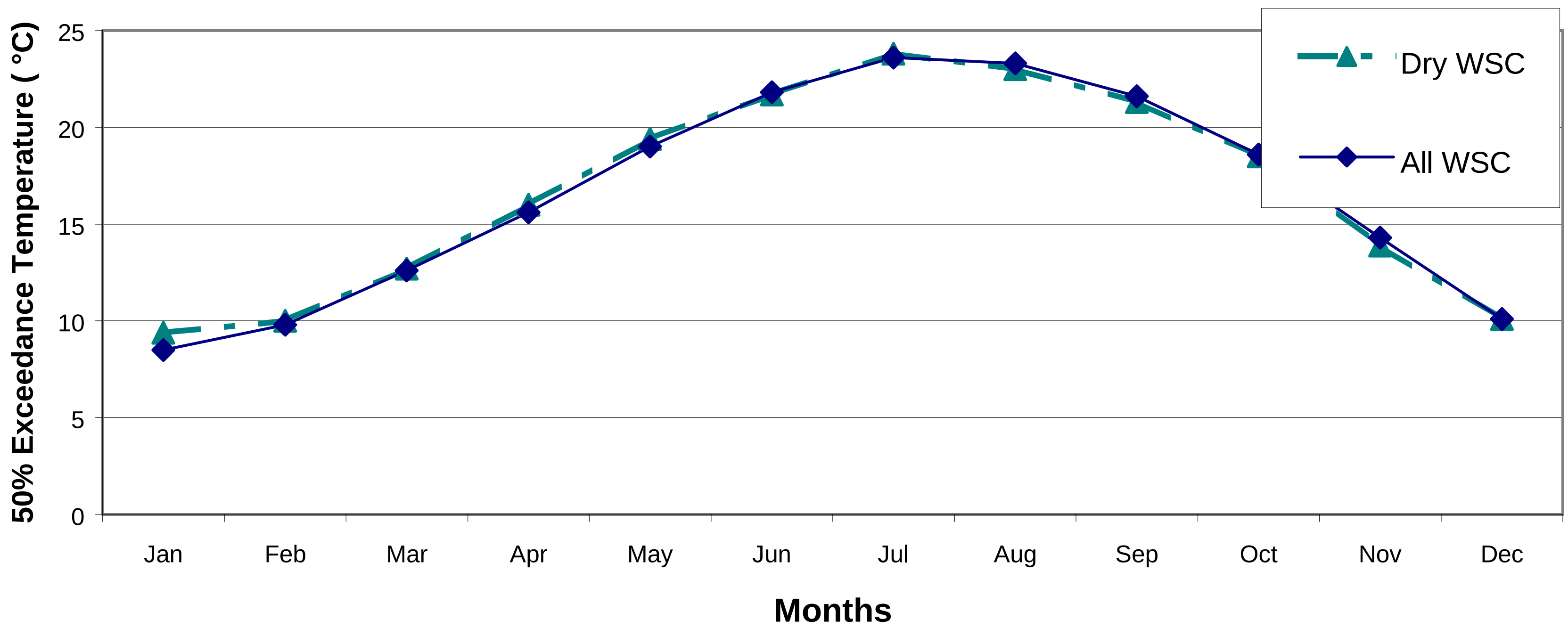

Figure 2-16 Median Daily Temperature in Russian River at Healdsburg under D1610

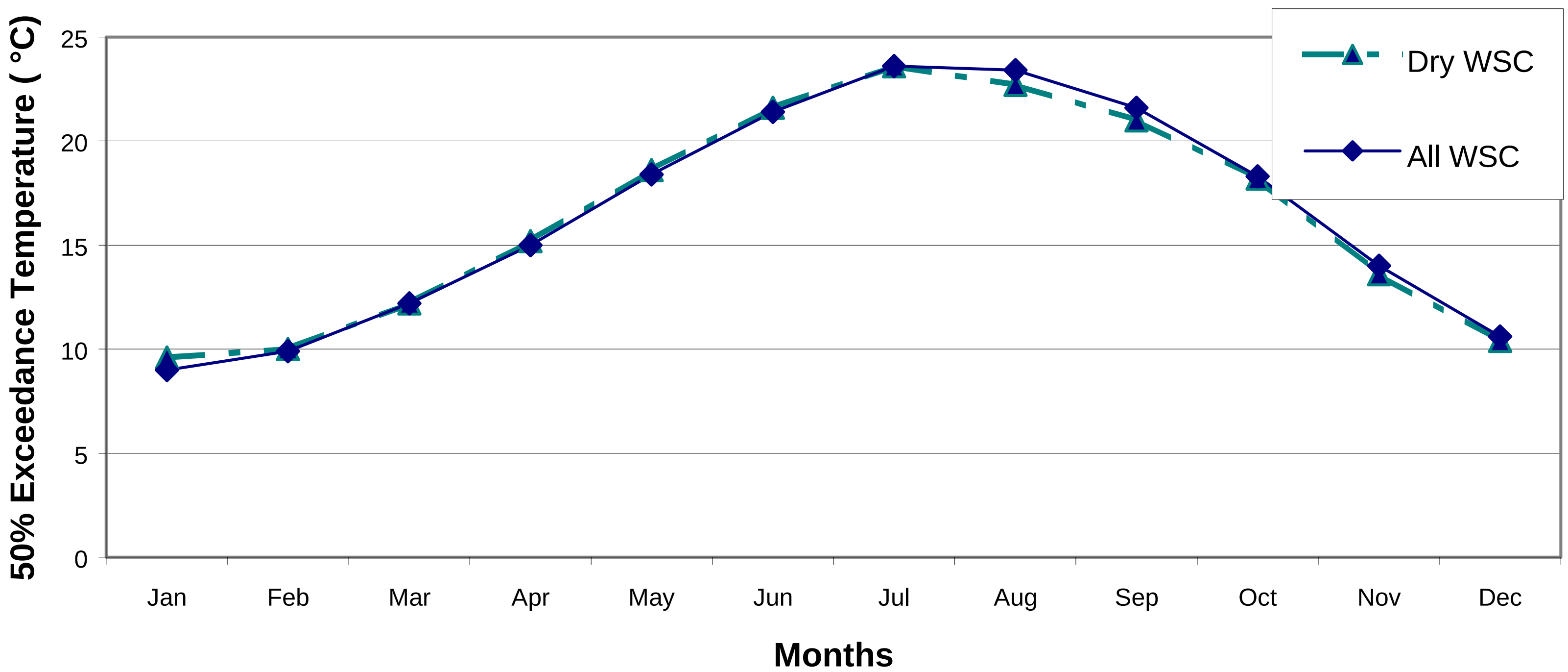

Figure 2-17 Median Daily Temperature in Russian River at Hacienda Bridge under D1610

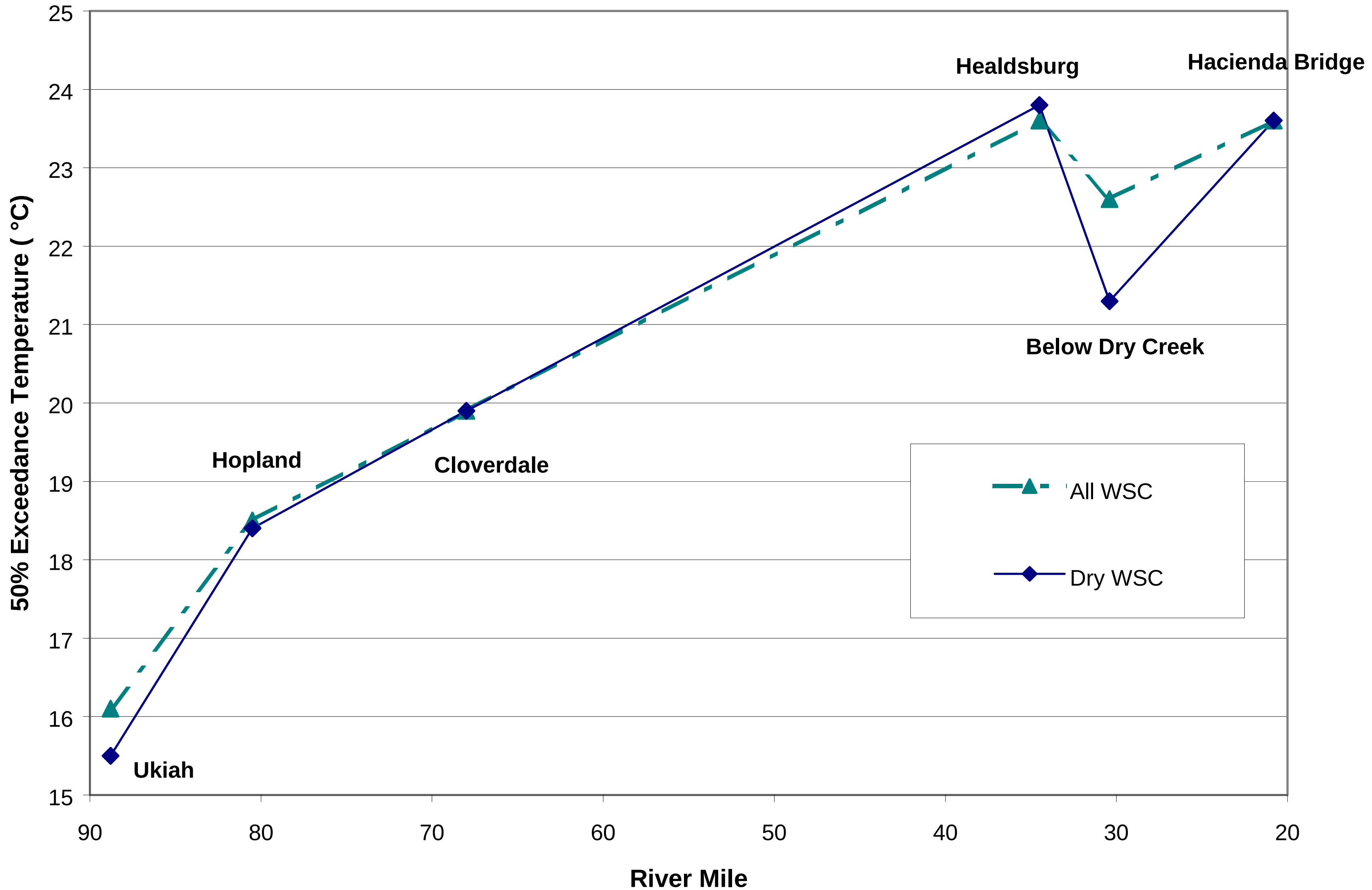

Figure 2-18 July Median Temperature Profile for the Russian River

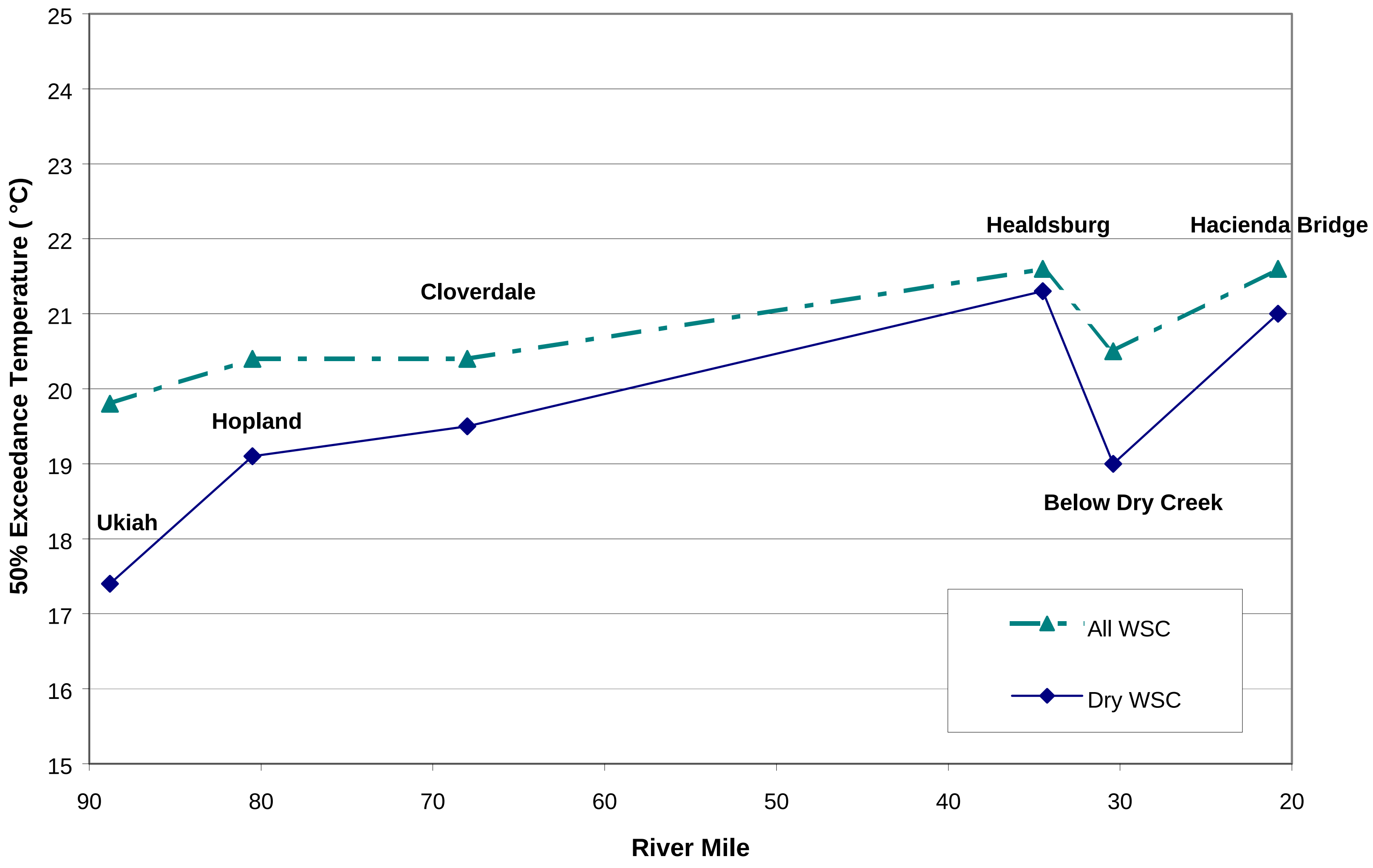

Figure 2-19 September Median Temperature Profile for the Russian River

Dry Creek

Figures 2-20 and 2-21 show a longitudinal profile of modeled water temperatures for Dry Creek during July and September. Water temperature increases in Dry Creek in a downstream direction, but generally remains within the suitable range for salmonids throughout Dry Creek.

Median water temperature of water released from WSD generally ranges from 12 to 13.5°C throughout the year (Figure 2-22). This water warms as it moves downstream. In July, one of the warmest months, water temperatures reach about 18.5°C above the confluence with the Russian River (Figure 2-20). In September, a cooler month, less warming occurs and temperatures above the confluence with the Russian River generally are less than 17°C (Figure 2-21).

2.5.2.6 Operational Considerations in Flow Regulation

For the purpose of managing water supply releases from Lake Mendocino and Lake Sonoma, the river can be evaluated in two sections. These are (1) the Russian River between Lake Mendocino and Healdsburg; and (2) the Russian River from Healdsburg to Jenner, including Dry Creek.

SCWA must release enough water from Lake Mendocino and Lake Sonoma to meet all senior downstream water diversions, and also ensure that releases are adequate to meet minimum flow requirements in the Russian River and Dry Creek. There are several factors that affect the amount of water released to water supply operations. These factors include the length of time it takes water to travel from the reservoirs to downstream monitoring points, changes in weather, and variability in water demands and diversions. SCWA does not control diversions other than diversions made at its diversion facilities.

Under D1610 during *normal* water supply conditions in the summer, minimum flows in the mainstem Russian River are 185 cfs at the confluence of the East Fork and 125 cfs at Guerneville. Under current demand during a normal summer, SCWA must release up to 300 cfs, and occasionally more, from Lake Mendocino to satisfy demand and meet the 185 cfs minimum flow requirement at Healdsburg. Because a change in release at Lake Mendocino may take up to three days to appear at Healdsburg (SCWA 1999a), SCWA maintains an operational margin of 10 to 20 cfs above the minimum flow requirement.

This provides the buffer necessary to ensure that as water use and diversions fluctuate, the minimum flow requirements will not be violated. To determine the effects of release changes, SCWA must allow downstream flows to stabilize before making additional release modifications.

Under D1610, minimum flows were established for the reach of Dry Creek between WSD and the confluence with the Russian River to assure fish passage during upstream spawning runs and downstream migrations. Minimum flows are determined by water supply condition (Figure 2-7). Under baseline conditions, summer flows in Dry Creek are largely determined by demand.

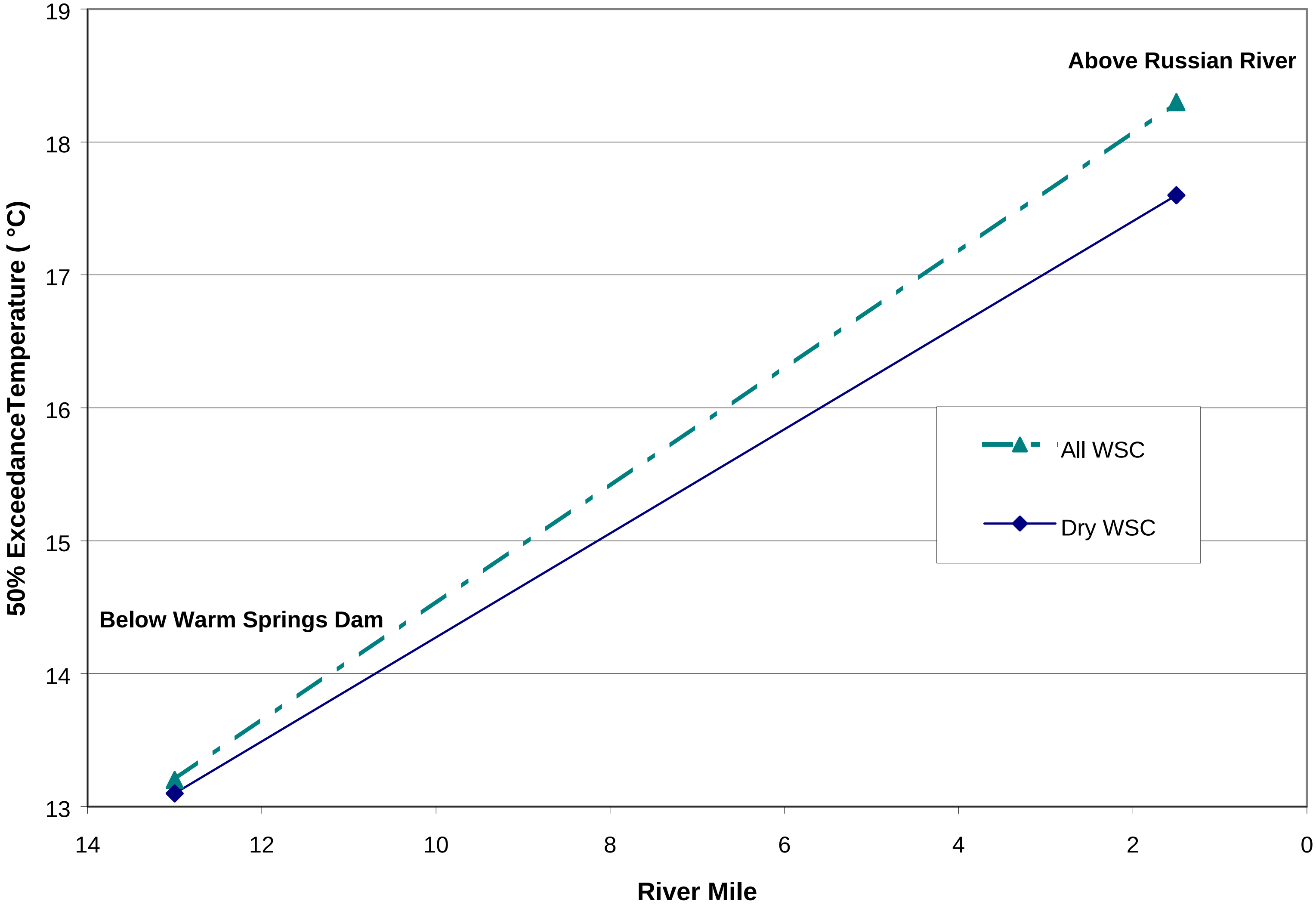

Figure 2-20 July Median Temperature Profile for Dry Creek

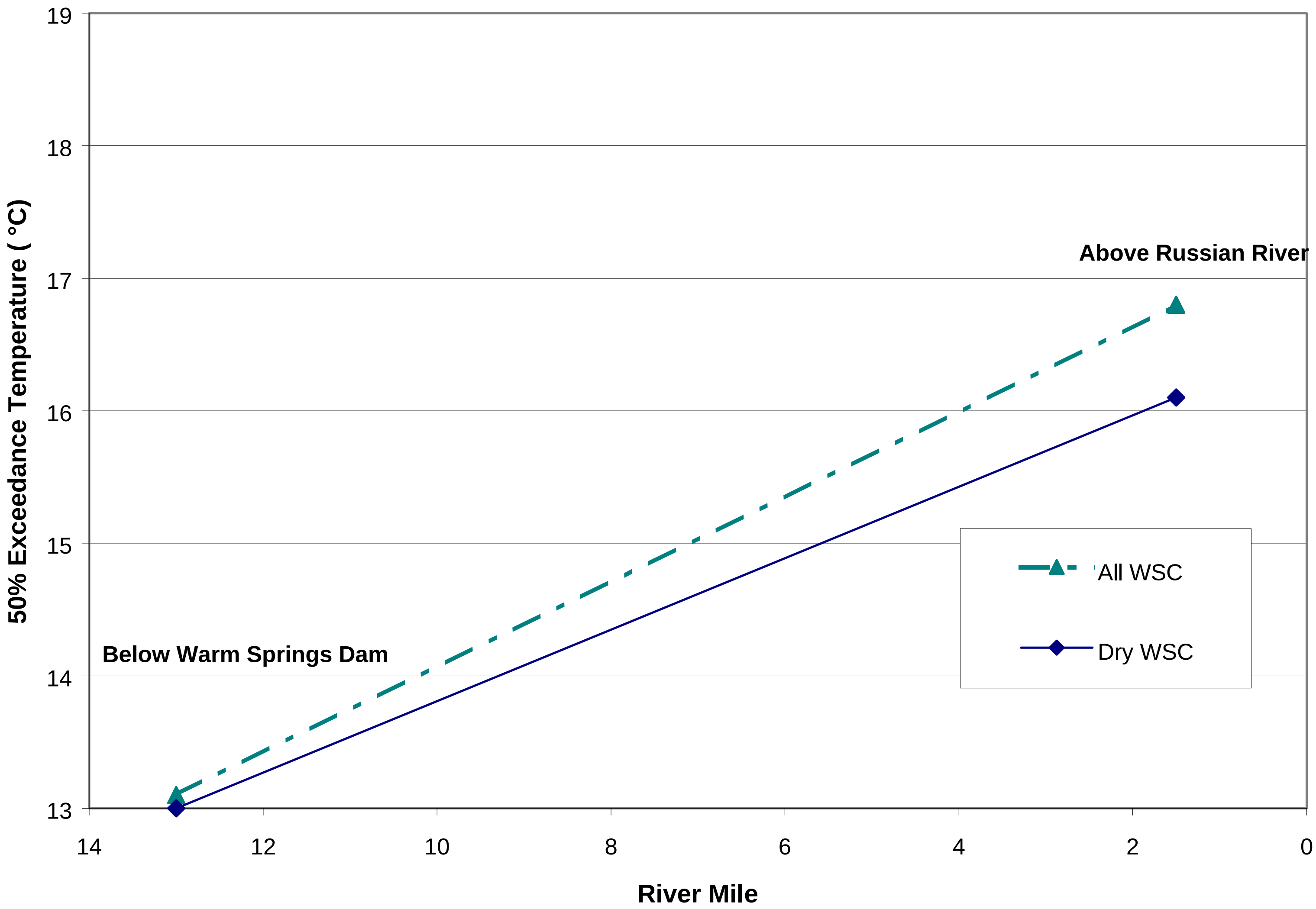

Figure 2-21 September Median Temperature Profile for Dry Creek

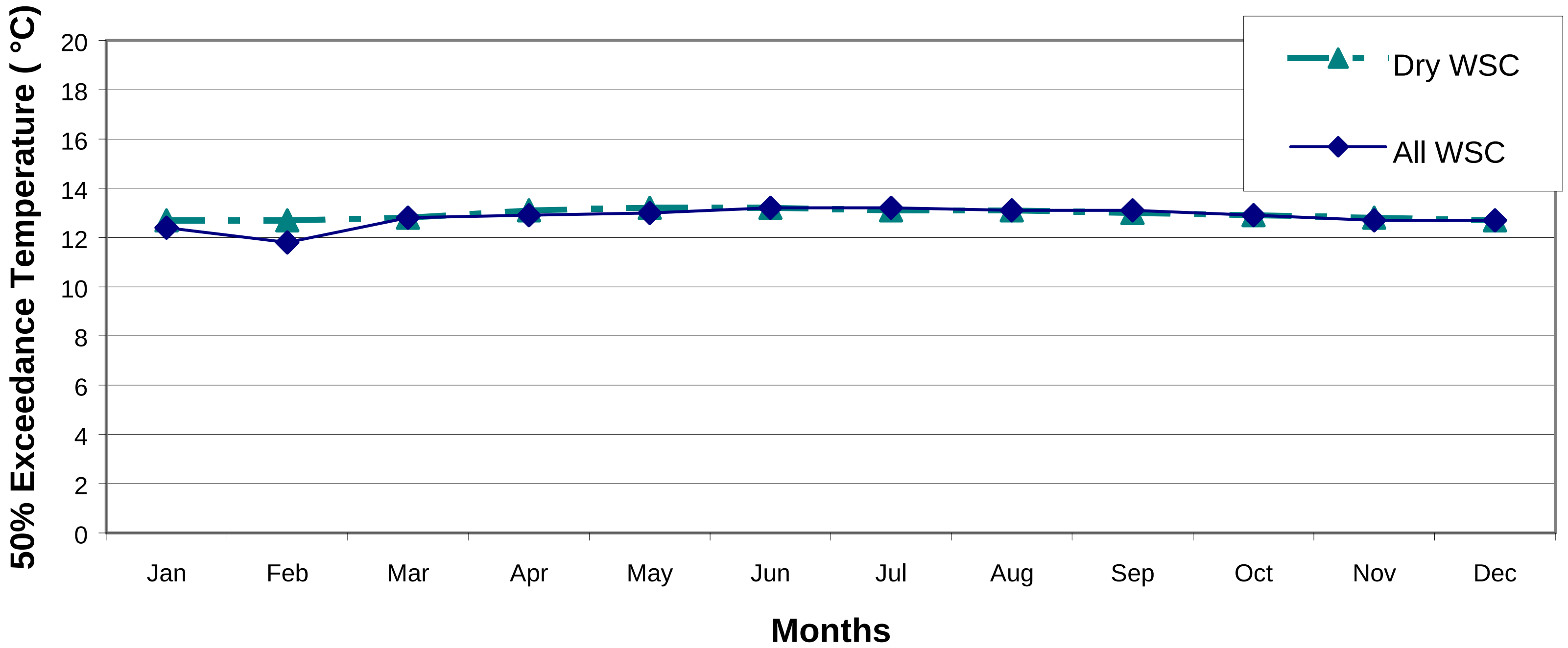

Figure 2-22 Median Daily Temperature in Russian River at Dry Creek below Warm Springs Dam

2.5.3 Water Demands

2.5.3.1 Historical Influences

The USACE survey report prepared before the construction of CVD concluded that the ultimate consumptive use requirement for irrigation in the Russian River Valley within Sonoma County was 16,000 AF. In 1961, the SWRCB determined that sufficient water (not to exceed 10,000 AF) from the Russian River Valley within Sonoma County should be reserved for use in the appropriative water rights permit issued to SCWA to meet its future requirements for ten years. After ten years, any water not contracted would be made available for use elsewhere. In 1974, the SWRCB amended this permit. Amendments included subjection to depletion by diversion of project water not to exceed 10,000 AF (10,000 AF reservation), elimination of the ten-year time limit, and allowing individuals to file applications with the SWRCB to appropriate the 10,000-AF diversion for agriculture and domestic purposes.

2.5.3.2 Present Demands

SCWA water rights permits are described in Section 1.4.3. Currently, SCWA is permitted to divert water to storage at Lake Mendocino and Lake Sonoma and to divert and redivert water from the Russian River at the Wohler and Mirabel pumping facilities. Currently, SCWA diverts and rediverts a total of approximately 60,000 AFY of water from the Russian River. However, the total water that can be diverted and rediverted under SCWA permits is 75,000 AFY at a maximum rate of 180 cfs.

It is estimated that there are presently over 600 diversions by various entities along the mainstem of the Russian River and approximately 800 other diversions along the tributaries of the Russian River (SCWA 1996). The uses of diverted water include municipal, domestic, agricultural, and industrial. SWRCB records list a total of over 1,500 water rights filings for the Russian River watershed. SCWA estimates that the present total diversion demand on the Russian River and its tributaries by all users, including agriculture and urban, is 111,076 to 120,254 AFY, depending on the amount of rainfall per year. Approximately 41,083 to 49,162 AFY of this demand occurs on the Russian River upstream from Dry Creek, where agricultural uses account for most of the total. Diversions along Dry Creek below WSD and along the Russian River downstream of the confluence with Dry Creek total about 70,000 AFY including SCWA’s diversions. Municipalities and agricultural interests are the primary diverters.

2.5.3.3 Future Demands

More than 100 applications are pending before the SWRCB for permits to divert water from the Russian River and its tributaries. Most of these applications are for diversions on 13 different tributary systems. The total identified future demand is estimated by SCWA to be from 173,500 to 184,500 AFY at buildout. (Buildout is the water supply and demand conditions at full implementation of the supply and transmission facilities authorized in the WSTSP.) Approximately 58,000 to 68,000 AFY of the total future demand is projected to be upstream of the confluence with Dry Creek.

2.5.4 TRANSMISSION SYSTEM FACILITIES

SCWA delivers water to its customers through its water transmission system, which has a current delivery capacity of 92 mgd. The diversion and treatment facilities are located along the Russian River at Mirabel and Wohler. The distribution system includes pipelines, storage tanks, pumps, and groundwater wells, and conveys water from the diversion facilities on the Russian River to service areas in Sonoma County and in northern Marin County. The locations of SCWA's existing water transmission system facilities are shown in Figure 2-23. The operations and maintenance activities at the existing diversion facilities are described in the following sections.

2.5.4.1 Existing Diversion Facilities – Operation

SCWA’s diversion facilities along the Russian River are located in the Wohler and Mirabel areas, on SCWA property (Figure 2-24). They include the inflatable dam, the Mirabel diversion facility and infiltration ponds, and the Wohler diversion facility and infiltration ponds. SCWA operates five Ranney collector wells and seven conventional wells adjacent to the Russian River near Wohler Road and Mirabel, which extract water from the aquifer beneath the streambed. Each Ranney collector well consists of a 13- to 16-foot-diameter caisson (i.e., concrete cylinder) that extends 80 to 100 feet deep into the streambed gravel. Perforated horizontal intake pipes extend radially from the bottom of each caisson to a maximum of 180 feet into the aquifer. Each collector well houses two vertical turbine pumps that are driven by 1,000 to 1,250 horsepower (hp) electrical motors.

The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed near Mirabel and Wohler. To augment this rate of recharge, SCWA has constructed seven infiltration ponds (and one sedimentation pond). A water-filled inflatable dam is located on the Russian River just upstream of the Mirabel area (Figure 2-24). When the dam is inflated, it raises the water level and submerges the intakes to three diversion pumps. The water is pumped through pipes in the levee adjacent to the river into a lined ditch, which conveys water to five infiltration ponds at approximately 40 acres in area. The backwater created by the inflatable dam also raises the upstream water level, allowing SCWA to flood two infiltration ponds (1.7 acres combined) in the Wohler area. The flow of water to these ponds is controlled by slide gates at the entrance of the canals serving each pond. The backwater created by the inflatable dam submerges a larger streambed area along the river, which increases water depth and submerged area. This significantly increases infiltration to the aquifer and increases the yield of all five Ranney collector wells.

Inflatable Dam

The inflatable dam is fabricated of a rubber material and is attached to a concrete foundation in the riverbed. When inflated, the dam is 11 feet high. The diversion facility is located on the west side of the river adjacent to the dam. The inflatable dam is usually raised in late spring when water demands increase and the Russian River flows drop to between 150 cfs to 750 cfs. The dam is lowered again in the fall or early winter when demands decline and river flows increase. Table 2-14 shows the dates that the inflatable dam was raised or lowered, and the corresponding river flows, between 1978 and 1998. During this period, the average river flow at the Hacienda gage was approximately 560 cfs when the dam was raised and lowered. Because of increasing water demands, SCWA has had to raise the dam at increasingly higher river flows. In general, the river flows are declining when the dam is raised and rising when the dam is lowered. The dam has been inflated for slightly under seven months each year, on average. Under some spring conditions, when demands were rising sharply, the dam was raised when flows were between 1,000 cfs and 2,000 cfs. When the dam is deflated, it does not impede migration or create a backwater (Winzler and Kelly 1978).

The inflatable dam is equipped with Denil-style fish ladders near the riverbank on each side of the dam, both of which are in operation when the dam is raised. Each fish ladder has an approximate capacity of 40 cfs. Two 24- to 36-inch bypass pipelines provide water at each of the fish ladder entrances to attract adult fish to the ladder. Each bypass pipeline can allow approximately 22 cfs of flow. Downstream migrants can either pass over the dam, down the fish ladders, or through flow bypass pipes.

The bypass pipeline on the east side of the river causes excessive turbulence at the downstream entrance of the east-side fish ladder. The west-side bypass line and fish ladder function properly.

Diversion Structures and Infiltration Ponds

When the inflatable dam is raised, surface water is diverted into infiltration ponds at Mirabel and Wohler to increase water production.

<u>Mirabel</u>

At the inflatable dam, water is drawn through two rotating-drum fish screens to the diversion caisson, which houses three pumps capable of pumping a total of 100 cfs to the infiltration ponds. Diversion rates to the infiltration ponds are determined by demands on SCWA's water supply and transmission system. After flowing through a sedimentation pond adjacent to the diversion caisson, diverted water enters a small open channel, which distributes water to each infiltration pond through manually-operated slide gates.

Existing fish screens for the Mirabel pumped diversions were constructed in 1976 as part of the overall diversion facility, which included the inflatable dam foundation, inflatable dam fabric, diversion caisson, and other related equipment. The fish screens are submerged on the west side of the river in a side structure (pool), and when in operation, the screens appear to have little variability in hydrologic conditions. The water surface elevation typically ranges from 37 to 38 feet MSL during normal summer operation.

The two fish screens at Mirabel are 11 feet in diameter, 5 feet 4 inches high, and rotate with a vertical axis. The top portion of the screens, which are submerged, have a different configuration than the rest of the screens; they are horizontal rather than vertical. Screen opening size is 5/32 inch. The diversion pumps are capable of pumping a total of 100 cfs

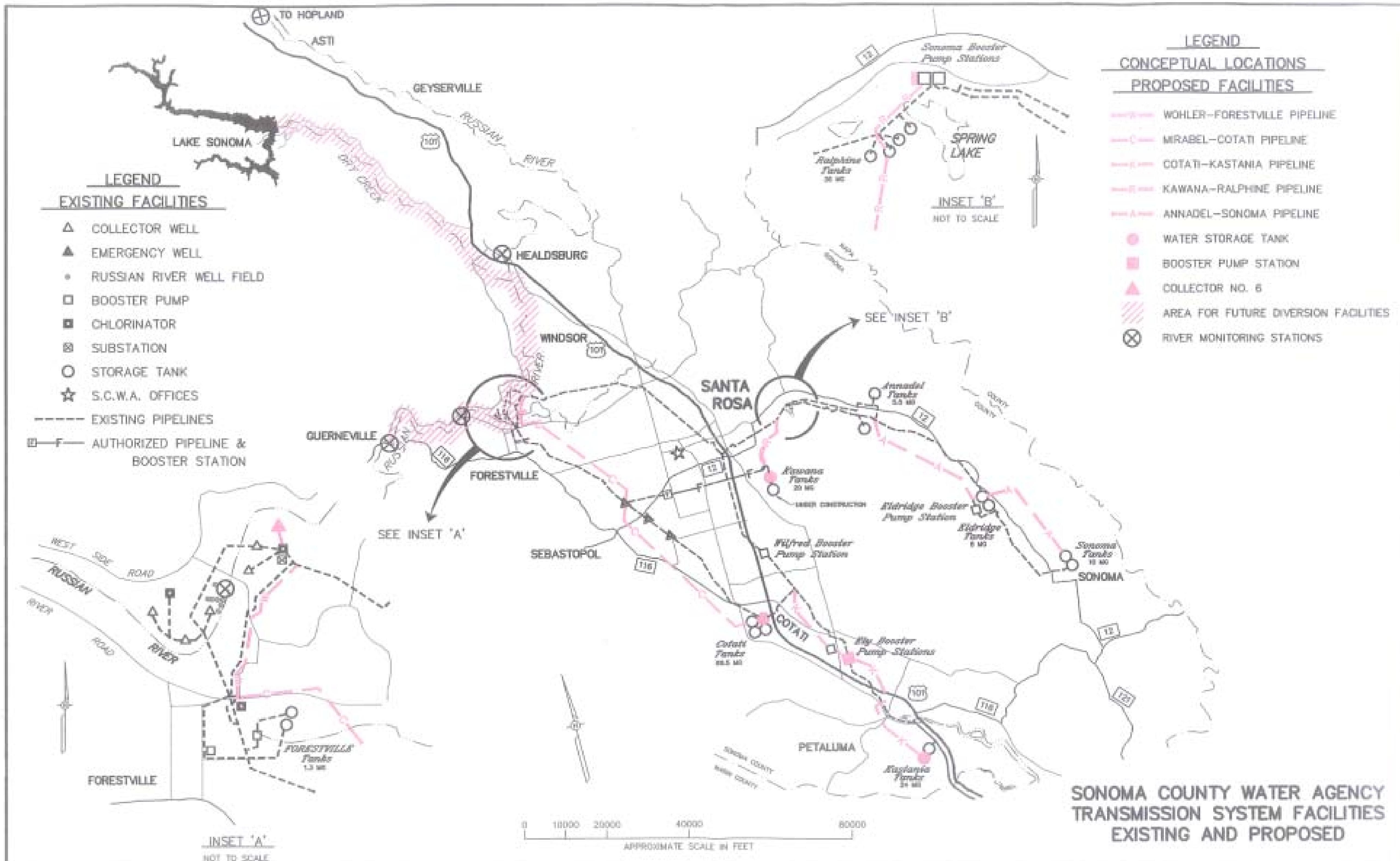

Figure 2-23 Sonoma County Water Agency Transmission System Facilities Existing and Proposed

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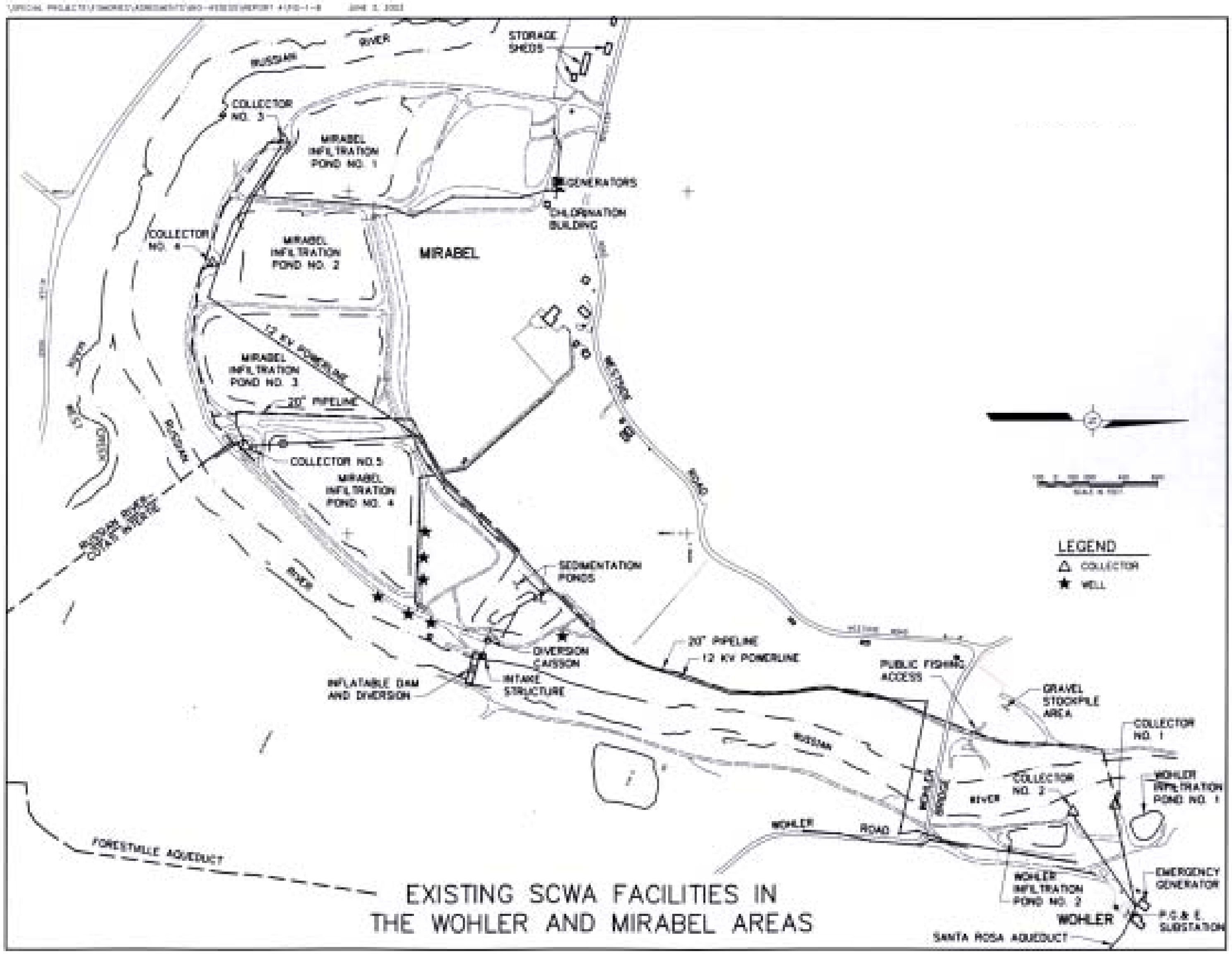

Figure 2-24 Existing SCWA Facilities in the Wohler and Mirabel Areas

Table 2-14 Inflatable Dam Operation History

DATE		DEMAND LOW	DEMAND HIGH	DEMAND AVG	MAX TEMP LOW	MAX TEMP HIGH	MAX TEMP AVG	HACIENDA 8 AM FLOW (Raising)	HACIENDA 8 AM FLOW (Lowering)	7 DAY RAINFALL	SPECIAL NOTES
		PRIOR 7 DAYS									
4/21/79	up	16.0	30.0	21.9	63	78	70			0	
10/7/79	down	26.1	31.2	28.6	75	87	80			0	
4/21/80	up	17.3	21.2	19.3	62	82	75			0.59	
9/14/80	down	32.7	37.2	34.9	71	81	77			0	
5/14/81	up	36.4	47.5	44.0	77	92	86			0	
10/7/81	down	25.4	36.3	28.9	67	87	76			0.77	
6/7/82	up	35.2	48.0	39.9	75	82	78			0	
10/7/82	down	29.4	34.2	32.2	68	80	76			0.05	
6/8/83	up	35.1	47.4	39.8	74	94	84			0	
10/19/83	down	25.8	30.4	28.1	72	78	76			0	
5/12/84	up	37.4	47.4	41.5	77	90	84			0	
10/17/84	down	29.6	35.1	32.2	57	74	69			0	
5/6/85	up	39.2	45.7	41.9	67	75	71			0	
10/21/85	down	27.4	45.9	37.5	61	82	69			1.13	
5/17/86	up	39.1	46.3	44.0	75	91	80			0	
10/21/86	down	35.9	42.8	39.3	64	77	70			0	
4/27/87	up	45.0	52.2	48.3	70	92	79	370		0	
11/12/87	down	30.1	36.2	33.5	64	68	67		248	0.38	
4/2/88	up	42.6	50.9	46.6	65	82	75	330		0	
11/2/88	down	34.2	42.3	39.0	58	75	66		174	0.15	
2/21/89	up	28.8	39.6	36.9	54	69	61	454		0.26	Hacienda flow 450 cfs North Marin Water taking 5-6 MGD extra with new pump
3/2/89	down	35.7	41.8	39.4	55	69	62		1536	2.03	Winter storm in prog- ress HAC flow 1536 cfs
5/10/89	up	40.3	51.5	49.3	65	88	75	625		0	
10/1/89	down	34.9	47.3	42.6	70	75	72		241	0.64	Construction work for emergency diversion
10/10/89	up	40.0	51.9	46.2	74	86	79	229		0	Construction finished
10/23/89	down	35.9	49.9	42.4	53	76	65		560	2.71	STORM
12/12/89	up	31.7	39.3	35.8	55	65	59	331		0	Low rainfall YTD
1/7/90	down	30.0	38.1	33.7	51	58	55		331	1.72	STORM
4/4/90	up	37.9	45.6	41.3	63	77	67	354		0	Streamflows reduced for dry year
12/11/90	down	35.2	45.9	39.6	53	64	60		171	0.36	cool Wx. low demand
1/18/91	up	39.5	45.6	42.1	59	71	63	145		0.06	
2/2/91	down	41.2	45.1	44.1	55	66	60		278	2.23	STORM
2/13/91	up	39.2	41.8	40.5	61	73	66	246		0	
3/2/91	down	36.6	47.1	42	58	75	64		1547	3.64	STORM
5/10/91	up	38.8	49.6					465			Estimate - date inferred from records of pumping to ponds
12/23/91	down								203		Estimate - date inferred from records of pumping to ponds
1/23/92	up							351			Estimate - date inferred from records of pumping to ponds
2/9/92	down								420		Estimate - date inferred from records of pumping to ponds
4/30/92	up							553			Estimate - date inferred from records of pumping to ponds
12/2/92	down								221		Estimate - date inferred from records of pumping to ponds

Table 2-14 Inflatable Dam Operation History (Continued)

DATE		PRIOR 7 DAYS DEMAND LOW	HIGH	AVG	MAX TEMP LOW	HIGH	AVG	HACIENDA 8 AM FLOW (Raising)	HACIENDA 8 AM FLOW (Lowering)	7 DAY RAINFALL	SPECIAL NOTES
5/10/93	up							367			Estimate - date inferred from records of pumping to ponds
5/25/93	down								292		Estimate - date inferred from records of pumping to ponds
6/11/93	up							1120			Estimate - date inferred from records of pumping to ponds
11/9/93	down								356		Estimate - date inferred from records of pumping to ponds
3/14/94	up							708			Estimate - date inferred from records of pumping to ponds
11/9/94	down								409		Estimate - date inferred from records of pumping to ponds
12/26/94	up							837			Estimate - date inferred from records of pumping to ponds
1/3/95	down								1303		Estimate - date inferred from records of pumping to ponds
6/1/95	up							733			Estimate - date inferred from records of pumping to ponds
12/7/95	down								278		Estimate - date inferred from records of pumping to ponds
5/20/96	up							1660			
11/18/96	down								460		
3/26/97	up							477			Estimate - date inferred from records of pumping to ponds
11/16/97	down								1270		
5/23/98	up							910			
5/28/98	down								883		
6/12/98	up										
								753.8	1326.3		
								145	171		

through the screens. Vertical fixed brushes clean the screens of debris and biological fouling as the screens rotate.

Field measurements were taken to evaluate the performance of the screens in June 2000 (Borcalli & Associates 2000). Table 2-15 presents critical operating parameters for the Mirabel fish screens and compares them with NOAA Fisheries screen criteria. Most of the critical operating parameters and engineering design criteria meet NOAA Fisheries screening criteria for juvenile salmonids, but not salmonid fry. The rate of diversion during the test was 100 cfs, and the amount of water flowing through both bypass inlets simultaneously was estimated at 18.5 cfs. The approach velocities at the Mirabel screens averaged 0.18 feet per second (fps) at the downstream screen and 0.41 fps at the upstream screen. Field data indicate that large portions of the screens have approach velocities below 0.45 fps, and some areas have negative approach velocity values, indicating flows away from the screen (Borcalli & Associates 2000). There are small areas along the screens where approach velocities are higher, up to 0.95 fps. The screens rotate, while these "hot spots" remain in a stationary position. Average sweeping velocity was 1.04 fps at the upstream screen and 0.45 fps at the downstream screen. Some sweeping velocity is created as the screens turn. Test results indicate that most of the flow is pulled through the upstream screen.

The drum screens were originally constructed with hydraulically driven motors to rotate the drums past the vertical fixed brush, which keeps the screens free of silt and other debris. In 1995, after a leak occurred in one of the hydraulic lines, the hydraulic motors were removed and replaced with a water-jet drive system. A small water jet drives paddle blades attached to the top of the screen to rotate the screens. SCWA maintenance staff has also found that the river current itself is often adequate to rotate the screens without assistance from the water-jet drive.

Table 2-15 Critical Operating Parameters for Mirabel Fish Screens

Parameter	Mirabel Fish Screens	NOAA Fisheries Juvenile Criteria[2]	NOAA Fisheries Fry Criteria[2]
Net equivalent submerged screen area	345.6 square feet[1]		
Screen open area	40%	40% open area	27% open area
Approach velocity	Upstream: Average 0.41 fps Downstream: Average 0.18 fps	≤ 0.8 fps	≤ 0.33 fps
Sweeping velocity	Upstream: Average 1.04 fps Downstream: Average 0.45 fps	Greater than approach velocity (sufficient to sweep debris away from screen face)	Greater than approach velocity (sufficient to sweep debris away from screen face)
Screen opening size (square openings)	5/32 inches	≤ ¼ (8/32) inches	≤ 3/32 inches

[1]Calculated from original construction drawing.
[2]NMFS 1997

Wohler

The Wohler diversion facilities consist of two ponds with a combined surface area of 1.7 acres. Currently, each pond is connected independently to the Russian River by a canal. These canals function as both inlet and outlet to the ponds. The ponds can only be flooded when the inflatable dam is raised and the level of the river surface is increased. The Wohler diversion facility operates when the inflatable dam is raised. Flows diverted into the Wohler ponds are not measured.

The conditions at the Wohler diversion, prior to 1999 modifications, are described in *Interim Report 4* (ENTRIX, Inc. 2001a). Prior to 1999, a screen constructed out of metal T-posts and 1/4-inch hardware cloth was installed in front of the inlet into the Wohler infiltration ponds.

Fish Rescue

The levees surrounding the infiltration ponds at Wohler and Mirabel are sometimes overtopped during floods, trapping fish in the ponds after the river level recedes. At Mirabel, this occurs only when the river rises to a gage level of approximately 37.7 feet or 3 feet above its flood level (as measured at the Hacienda Bridge). Prior to overtopping of the Mirabel pond levees, the slide gates on the canals are opened to allow water to enter the ponds. Back-flooding of the Mirabel ponds reduces damage to the levees caused by overtopping. The canals, which are built through the levee of Mirabel pond No. 3, are typically opened when the river level reaches approximately 36 feet, as measured at the Hacienda Bridge.

Wohler pond No.1 is overtopped when the river rises to a gage level of approximately 18.3 feet (as measured at the Hacienda Bridge) or 12,700 cfs. Wohler pond No. 2 is overtopped at 17.3 feet or approximately 10,600 cfs. Both of the Wohler ponds have flooded for extended periods of time during most winters.

Before 1996, CDFG informally conducted post-flooding fish rescue efforts at Wohler and Mirabel facilities as needed. SCWA assumed responsibility for fish rescue efforts with the establishment of its Fisheries Enhancement Program (FEP) in 1996. Fish rescues are accomplished by wading the ponds with beach seine nets after pond levels drop to a depth where wading is possible.

2.5.4.2 Existing Distribution System – Operation

Figure 2-23 shows the location of the pipelines (also referred to as aqueducts and interties), storage tanks, booster pump stations, and groundwater wells on the SCWA water transmission system. The pipeline system is designed to carry the anticipated average daily demand during the month of maximum demand (peak month), usually July or August. (Peak demand on the water transmission system reached a maximum average monthly demand of approximately 81 mgd in July 1999.)

The original pipeline system (consisting of the Santa Rosa Aqueduct, the Petaluma Aqueduct, and the Sonoma Aqueduct) was constructed in the late 1950s and the early

1960s. The two collector wells at Wohler provided the water supply to this original system. In the mid-1970s, demands in the service area increased, and the Russian River-Cotati Intertie pipeline and the three collector wells at Mirabel with connecting pipelines and additional storage tanks were authorized by the SCWA's water contractors. The Russian River-Cotati Intertie pipeline and two collectors were constructed immediately, and most of the remaining facilities were constructed in subsequent years.

Collector Wells

Ten vertical turbine pumps, two installed in each of the five Ranney collectors, provide the primary pumping for the distribution system. Each pump at Wohler is rated to deliver up to 10.0 to 11.5 mgd, and at Mirabel each pump is rated to deliver up to 10.0 to 14.5 mgd, although the highest pumping rates cannot be sustained on a continuous basis. The pumping capacity of each of the collectors is heavily dependent on the current storage and pumping status of other water transmission components. For example, one Wohler pump operating by itself will produce about 11 mgd, three pumps operating at Wohler produce about 27 mgd, and four pumps produce a total of about 30 mgd.

Groundwater Wells

The SCWA system includes three groundwater wells located along the Russian River-Cotati Intertie pipeline at Occidental Road, Sebastopol Road (Highway 12), and Todd Road. The three wells are shown on Figure 2-23.

Prior to 1999, these wells were used for emergency purposes only and were pumped for approximately 20 minutes each month to maintain their operability.

Chlorine is added to the water produced at each of the three well sites to maintain protective residual levels of chlorine within the system and prevent contamination. In addition, a treatment system has been installed at the Todd Road well, which adds a small dose of an ortho-polyphosphate compound to the well water. The treatment was installed to determine whether it would be effective at eliminating the hydrogen sulfide odor, which frequently occurs in the water produced at all three wells. Although the hydrogen sulfide does not affect the potability of the water, it is a secondary water quality concern, which significantly affects its taste.

Seven conventional wells, collectively referred to as the Russian River Well Field, are located in the Mirabel area, as shown on Figure 2-24. These wells withdraw water from the aquifer adjacent to the Russian River. The wells provide up to 7 to 9 mgd of additional production capacity. Water from the Russian River Well Field may either be sent directly to the Cotati Intertie, or it may be discharged into Caisson 1 and re-pumped into the Santa Rosa aqueduct.

Storage Tanks and Booster Pump Stations

Storage tanks provide water storage for emergencies, to meet peak demand during maximum demand periods, and to provide hydraulic stability. Figure 2-23 shows the location of water storage tanks. Sixteen steel water storage tanks in the system provide a combined storage capacity of 108.8 million gallons. Their locations and capacities are given in Table 2-16.

Operation of the water storage tanks in the SCWA system sometimes requires discharges of water from the tanks. These discharges are mostly under controlled conditions, although uncontrolled discharges may occur in some circumstances. This could result from a failure in valve control equipment, which is expected to be very infrequent.

Table 2-16 Location and Capacities of Water Storage Tanks

Tank Name	General Location	Number of Tanks	Total Capacity (million gallons)
Ralphine	Spring Lake Park, Santa Rosa	4	36.0
Cotati	West Sierra Avenue, Cotati	3	36.0
Forestville	Anderson Road, Forestville	2	1.3
Annadel #1	Oakmont, Santa Rosa	1	2.5
Annadel #2	Los Guilucos, Santa Rosa	1	3.0
Eldridge	Sonoma Valley Park, Valley of the Moon	2	8.0
Sonoma	1st Street West, Sonoma	2	10.0
Kastania	Kastania Road, Petaluma	1	12.0
TOTAL		**16**	**108.8**

The water transmission system also includes eight booster pump stations. Booster pumps are necessary to increase water pressure and/or to move water to areas of higher elevation. The station name, number of pumps at each station, and rated horsepower of each pump are shown in Table 2-17.

Table 2-17 Location and Capacities of Booster Pump Stations

Station Name	Number of Pumps	Total Rated Horsepower
Forestville #1	2	15
Forestville #2	2	60
Sonoma #1	3	855
Sonoma #2	1	250
Wilfred	1	700
Ely	2	1,000
Eldridge	1	75
Kastania	2	650

Pipelines

The pipelines in the SCWA water transmission system include valves, which may occasionally discharge potable water to various creeks and drainage swales or ditches.

These valves were installed to protect pipelines by relieving the pressure surges created when an abrupt change in flow occurs. Most, if not all, pressure surges and discharges occur when power outages trigger a sudden pump shutdown. There are six of these valves, referred to as slow-closing air valves or surge valves, in the SCWA system. Potable water may also be discharged from tank overflow lines, although this occurs far less frequently. The maximum residual chlorine concentration in these discharges is approximately 0.6 to 0.7 parts per million (ppm). The volume of such a discharge is difficult to estimate but is likely to be as much as several thousand gallons.

Another feature designed to protect the integrity of the pipeline system is cathodic protection, which consists of buried anodes, made of a cast magnesium alloy, attached to the pipeline at regular intervals. Cathodic protection prevents corrosion on the exterior of the SCWA pipeline using the anodes to generate a small electrical current in the pipeline. While the anodes reduce pipeline corrosion, these anodes can corrode and are replaced after several years. The buried anodes are typically installed at every one to two pipe joints, or every 20 to 40 feet. Not all of the SCWA pipelines were constructed with cathodic protection, and SCWA has an ongoing program to install anodes on approximately 2,000 to 4,000 feet of unprotected pipeline each year. Installation of the anodes involves excavation with a backhoe tractor to expose the pipe joint material, and installation of the anodes and anode test stations. These test stations consist of a wire lead to the ground surface, which allows operation and maintenance staff to test the anodes without excavating the pipeline. Where pipelines cross creeks or other waterways, anodes are installed on either side of the crossing behind the tops of the banks. In areas where anodes cannot be installed over a significant distance, a small direct current is applied directly to the pipeline.

2.5.4.3 Existing Water Treatment Facilities – Operations

Water diverted from the Russian River is filtered through the gravel aquifer below the streambed and infiltration ponds, requiring no further filtration. Gaseous chlorine is added for disinfection at approximately 0.6 to 0.7 ppm at three chlorination facilities.

In September 1995, SCWA completed construction of pH adjustment/corrosion control facilities to limit lead and copper content in drinking water. This system was constructed in response to 1991 Environmental Protection Agency (EPA) regulations. These facilities are located at the SCWA Wohler maintenance yard and the River Road chlorination building, which are shown on Figure 2-24. The facilities treat water in each of the SCWA's two primary water transmission lines, the Russian River-Cotati Intertie pipeline and the Santa Rosa Aqueduct, with caustic soda (NaOH). Although the water produced by the existing collectors contains no detectable levels of lead and copper, the water is naturally moderately corrosive and can leach lead and copper from indoor plumbing and water fixtures. Corrosion control treatment also assists the water contractors and other sanitation districts to meet water quality limits on the dissolved metals content in treated sewage discharges, which are even more stringent than the limits for drinking water.

SCWA currently adds about 0.6 parts chlorine per million parts water for disinfection. Chlorine has a low boiling temperature; therefore a leak from a chlorine tank would produce a gaseous cloud. In its gaseous state, chlorine is about 2½ times as heavy as air and is greenish-yellow in color. In its liquid state, chlorine is about 1½ times as heavy as water. Chlorine concentrations in the air above 3 ppm can usually be detected as an odor. Chlorine is normally delivered to SCWA's chlorine buildings in 1-ton pressurized cylinders. The pressurized cylinders are constructed in accordance with strict regulations and are capable of withstanding severe shock if dropped. The chlorine is mixed with water inside the chlorine buildings to form a concentrated chlorine and water solution. This chlorine and water solution is transported through underground pipes to each collector. The chlorine and water solution is injected into the collector caissons to sanitize the water. The water is then passed through a dechlorination facility to remove the residual chlorine before it is pumped into the transmission system. SCWA buildings that house chlorine are equipped with leak detection alarm systems that send a signal to the operations and maintenance center indicating the location of any leak; the alarm also sounds at the chlorination building. Chlorine is stored in 100-lb. cylinders at the Occidental, Todd, and Sebastopol roads well sites.

Caustic soda is purchased as a 50 percent water, 50 percent caustic soda solution, delivered by tanker trucks, and stored in two 10,000-gallon containers (one at Wohler and one at the River Road facilities). The Wohler pH control building is located approximately 250 yards from the Russian River. The River Road pH control building is located approximately 200 yards from Mark West Creek. The concrete masonry walls of the pH control buildings are designed to provide secondary containment to prevent caustic soda from contaminating a large area if a leak occurs within the pH control buildings. Caustic soda (sodium hydroxide) is used by SCWA to raise the pH level of the water to reduce the corrosion of copper pipes in household plumbing. The adjusted pH levels also help wastewater treatment facilities meet the discharge standards for copper levels in treated wastewater. In its concentrated form (50 percent solution), caustic soda has a corrosive action on body tissues. It can cause burns, deep ulcerations, and scarring. Caustic soda does not have the low boiling point of chlorine and is safer to handle or contain in the event of an accidental spill. The primary hazard of concentrated caustic soda is its extreme corrosivity.

Minor amounts of chlorinated water are discharged from the Ranney collector wells and other nearby facilities. These may be discharges from sampling and motor cooling lines in the collector wells, which operate continuously; from pumps used to dewater the Ranney collector wells for maintenance; from the inflatable dam as it is lowered; or from other related activities. Water from motor cooling lines is discharged at an estimated rate of approximately 5 gallons per minute (gpm) when the pump motors are running. This discharged water at the Mirabel facilities flows into the settling and infiltration ponds. At Wohler, this discharge water flows into the Russian River. SCWA is currently looking into other options for cooling to alleviate this discharge. These incidental discharges and the pipeline discharges are covered under a waiver issued by the RWQCB in 1987 (RWQCB Resolution 87-113).

Early Warning System

Prior to authorization of the WSTSP, the construction of an "early warning" system to alert SCWA to the presence of contaminants in the Russian River had been authorized. The Early Warning Station Project was initiated in 1991 in response to requirements set forth by the CDHS as part of SCWA's domestic water supply permit. Three early warning station sites were constructed in Sonoma County. Early Warning Station No. 1 is located off of Westside Road, adjacent to the Mirabel diversion facilities. Early Warning Station No. 2 is located near Mark West Creek, just downstream of its confluence with Windsor Creek. Early Warning Station No. 3 is located near the Healdsburg Memorial Dam on the westerly bank of the Russian River.

Each early warning station consists of a river intake, river sample and discharge line, biomonitor and physiochemical monitors, and auto sampler and telemetered alarm system housed within an 8-foot by 12-foot masonry or metal building. The original early warning system was designed to use the behavior of living organisms (fish or aquatic invertebrates) to detect contaminants. All three of the early warning stations are not operational due to problems with clogging filters. Because of the ongoing operation problems, the use of living organisms to detect contaminants is no longer being considered at the present time.

2.5.4.4 Existing Diversion Facilities – Maintenance

Road and Levee Maintenance

Main levee roads on the west side of the river in the Mirabel area are gravel roads that are maintained on an as-needed basis after storms. The main levee road is approximately 250 feet from the Russian River. Maintenance generally includes grading and replacement of gravel. This road provides access to the Mirabel collector wells, infiltration basins, diversion caisson, and the west side of the inflatable dam. This road continues north underneath the Wohler bridge along an intertie pipeline route that connects the Wohler and Mirabel facilities. This road is also used as an access location for periodic scraping of two large gravel bars that form under and upstream of the Wohler Bridge.

Access roads at Wohler are dirt roads that are generally maintained during the spring to repair damage from high river flows that can occur during the winter months. The road is used to access the Wohler collectors, and continues south along the east side of the Russian River to access the east side of the inflatable dam. Maintenance generally consists of repairing washouts and filling potholes. This road is approximately 200 feet from the Russian River.

Inflatable Dam Maintenance

Each time the dam is lowered, the fish screens at Wohler are removed so they are not damaged during high-water events. Raising the dam sometimes requires removing gravel that has accumulated during the winter on top of the flattened dam fabric and within the fish ladders. The accumulated sediment is removed using a portable suction dredge, and discharge is directed to a temporary siltation (settling) pond to prevent turbid water from reaching the river channel. The water is allowed to re-enter the river after the sediment has settled. Spoils are then stored out of the flood plain or hauled away.

Infiltration Pond Maintenance

Because silt and other organic materials accumulate on the infiltration pond beds and gradually impede infiltration to the aquifer after sustained use during the summer, the ponds are periodically drained and the silt and organic matter removed with a grader and scraper to restore infiltration capacity. The materials are stockpiled and removed over time by private contractors.

Extensive repairs are sometimes necessary for pond and levee maintenance at the Mirabel and Wohler sites if they are overtopped during flood conditions. When the river overtops the Mirabel levee at its low points, cascading water on the inboard side of the levee causes substantial erosion damage to the levee embankment. Culverts that run through the levees at Mirabel are equipped with slide gates so that they can be opened during flood conditions. If overtopping of the levees is probable, the slide gates are opened to fill the infiltration ponds and reduce erosion from water running over the top of the levees. Repairs to the levee require replacing the eroded material and rock riprap on the embankment. Flood water also deposits as much as one to two feet of impermeable silt material in the pond beds, which must be removed before the ponds can be used again. The removed material is placed on separate stockpiles at the Wohler and Mirabel sites.

Gravel Bar Maintenance

In addition to the infiltration ponds, SCWA augments infiltration rates by periodically scraping gravel bars in the river diversion areas to increase infiltration in the river. The gravel bars are graded to lower the level of the streambed so that the area is flooded when the inflatable dam is raised. A detailed discussion of gravel bar grading operations and channel maintenance activities is provided in Section 2.7.

2.5.4.5 Existing Distribution System – Maintenance

Groundwater Wells Maintenance

Operation of SCWA's Occidental Road, Sebastopol Road, and Todd Road wells frequently requires discharging well water to surface drainages for sampling or flushing purposes. These discharges usually involve unchlorinated water, although minor discharges of chlorinated water from nearby locations on the Russian River-Cotati Aqueduct pipeline may be necessary for sampling purposes. This sampling is for water quality parameters that are normally used to determine compliance with potable water regulations.

Water Storage Tanks Maintenance

Maintenance of the water storage tanks includes periodic recoating of the interior tank surfaces, which requires that the tanks be emptied. To the extent possible, the water in the tanks is drained into the transmission system. However, to maintain pressures within the transmission system, a portion must be released from the tank to surface water drainage. In these cases, the SCWA maintenance staff estimates the remaining volume and adds a corresponding amount of dechlorinating chemical (metabisulfide) to eliminate any chlorine residual in the discharge.

Controlled discharges occur approximately once every four years as part of maintenance activities. Controlled discharges are done only after obtaining permission from the CDHS and the RWQCB. The Forestville tanks are the SCWA's closest tanks to the Russian River (approximately 1 to 2 miles). Discharges from the Forestville tanks flow into a riprapped drainage ditch adjacent to the access road off of Anderson Road in Forestville. Riprapping in the drainage ditches serves to dissipate the energy of discharged flows to reduce the potential for erosion. Discharges into this ditch flow in a southwesterly direction towards an unnamed tributary of Atascadero Creek approximately 0.5 miles to the south. Atascadero Creek is a tributary of Green Valley Creek, which eventually flows into the Russian River.

Overflow pipelines in each water storage tank provide a necessary emergency release route if water levels in the tank should unexpectedly rise too high. While automated control valves in the water transmission system have been installed to prevent this, overflows may nonetheless occur under certain unforeseen circumstances. In these cases, chlorinated water may be discharged to surface water drainage. At a maximum, the water in the tanks would have a chlorine level of approximately 0.6 ppm.

Equipment Maintenance

Maintenance of equipment is a continual process with varying work schedules. Maintenance of facilities occurs on a weekly, monthly, quarterly, annual, and tri-annual basis. Maintenance work on diversion and distribution facilities is done either inside of the facility (inside the caisson or motor housing), or the equipment is brought back to SCWA's operations and maintenance building in Santa Rosa for maintenance. The storage yard at Mirabel is used to store small amounts of supplies needed for maintenance activities (paints, oils). Occasionally, the storage area at Mirabel is used as a staging area to store anti-freeze as part of maintenance activities associated with the diesel generators at Mirabel.

SCWA uses diesel fuel-powered generators for emergency and standby power production. SCWA has a total of approximately 31,000 gallons of diesel fuel storage capacity at various facilities. Diesel storage is located adjacent to the standby generators at the Wohler and Mirabel chlorine buildings. Both diesel storage locations are approximately 250-300 yards from the Russian River. Diesel fuel is stored in above-ground, double-containment tanks that are out of the floodplain. Concrete block walls around fuel tanks provide additional containment capability. Fuel tanks are designed, manufactured, and constructed in accordance with the Uniform Fire Code, the Uniform Building Code, and applicable local codes and ordinances.

2.5.5 Factors Affecting Species Environment Due to Flow and Water Supply Operations

2.5.5.1 Flow-Related Habitat under D1610

To evaluate the effect of flow on salmonid habitat quality, a flow-habitat study was conducted by USACE, SCWA, NOAA Fisheries, and CDFG in late 2001. The results of this study were used to evaluate the effects of flow under baseline conditions. The best potential habitat for salmonid rearing was present in Dry Creek when flow releases from WSD were approximately 50 to 90 cfs (ENTRIX, Inc. 2002b). Steelhead rearing habitat in Dry Creek was generally more abundant at flow releases from WSD of 50 cfs than at 130 cfs. Habitat availability at flow releases of 90 cfs was more similar to that at 50 cfs than at 130 cfs. The data also indicated that habitat availability for Chinook salmon fry and juveniles was similar at flow releases of 50 and 90 cfs. There was little available habitat for coho salmon at flows studied, due to poor channel structure, lack of deep pools, and the lack of woody debris or other cover. These features constrain habitat for both fry and juvenile coho salmon.

The flow-habitat study indicated that the best potential habitat conditions for salmonid rearing in the upper mainstem Russian River occurred when flow releases from CVD were approximately 125 cfs. Flow releases of 190 cfs provided good rearing habitat conditions, but flow releases of 275 cfs or greater habitat conditions salmonid rearing in the upper mainstem deteriorated.

Based on this study and on the analyses presented in *Interim Report 3* (ENTRIX, Inc. 2002a), the following issues were identified for flow regulation under baseline conditions (D1610):

- Water velocities in Dry Creek are higher than optimum for salmonid rearing.
- Water velocities in the upper mainstem of the Russian River are higher than optimum for salmonid rearing.
- Current operations result in frequent artificial breaching of the sandbar at the mouth of the river during some parts of the year. Reducing flow to the Estuary and keeping the sandbar closed during the summer months may improve salmonid rearing habitat.
- Storage levels in Lake Mendocino may be inadequate to maintain a cold-water pool sufficient to regulate temperatures in the upper Russian River during the late summer and early fall.
- Expanded warmwater habitat in the middle and lower Russian River favor fish species that prey on or compete with steelhead and salmon.

2.5.5.2 Juvenile Salmonid Emigration Delay

When inflated, the Mirabel Dam and the impoundment (approximately 3.2 miles long) have the potential to delay outmigrating smolts. Because smolts have a finite time to complete the physiological change that prepares them to survive in saltwater (smoltification), a substantial delay potentially reduces survival.

To evaluate the effects of baseline activities, SCWA instituted a five-year monitoring program to assess juvenile steelhead passage. This study was implemented after the MOU was signed, but data from this study are included in the environmental baseline to describe conditions that existed before the MOU.

Data suggest that steelhead smolt outmigration is delayed when the dam is inflated (Manning et al. 2000, 2003). Chinook salmon smolt emigration does not appear to be delayed by the dam (Chase et al. 2002).

From 2000 to 2002 SCWA used radiotelemetry to evaluate steelhead migratory behavior, passage, and survival in the seasonal reservoir created by Mirabel Dam. In spring 2000, 79 yearling smolts from the DCFH were surgically implanted with uniquely coded transmitters and released in groups of 19 to 20 fish on four occasions before and after the dam was inflated. Two telemetry receivers were used to track smolts in the reservoir and automatically record passage around the dam.

During 2001 and 2002, smolt movements were recorded with four fixed radio-tracking stations that each consisted of a three- or four-element Yagi antenna and datalogging receiver. The fixed stations were located as follows: Station 1, at the upstream end of the 4.5 km river reach; Station 2, at the upstream end of the 5.1 km-long impoundment; Station 3, in the dam forebay; and Station 4, 50 meters below the dam. To evaluate passage routes at the dam, Station 3 was configured to simultaneously monitor an array of one aerial and six underwater antennas.

2000 Results and Significant Findings

Radiotelemetry data from 79 radio-tagged smolts showed that the percentage of fish that passed the dam site decreased over time and differed substantially before (85 to 90 percent) and after (42 to 50 percent) the river was impounded (Manning et al. 2001). With the dam inflated, between 50 and 95 percent of the smolts spent more than 48 hours in the impoundment and some fish resided in the reach for up to 11 days before passing the dam. Smolt reluctance to pass the dam appeared to be related to depth and flow conditions in the forebay. The delay of some fish may have been exacerbated by the onset of parr-reversion (i.e., reverting back to a pre-smolt condition), stress related to surgery, and elevated water temperatures.

2001 to 2002 Significant Findings (Chase et al. 2003, Manning et al. 2003)

1. Year 2001 and 2002 data showed that steelhead smolts traveled through the river and reservoir at roughly the same rate despite decreased velocity in the reservoir. Travel rates were more rapid through the reservoir in both years, but did not differ significantly. Similarities in both years are remarkable despite differences in river flow. The magnitude of flows over the study period did not appear to affect travel rate and smolts from different hatchery-year classes performed similarly. The

similarity in travel rates between reservoir and river suggests that delays associated with the reservoir are limited to the forebay.

2. Residence time in the river above the dam did not differ significantly among years.

3. The ability to compare passage among years was partially confounded by the release of half the smolts at the upstream end of the reservoir in 2002. Although fish that showed little inclination to move from the upper reservoir release site were disregarded, a higher-than-expected proportion of fish from those releases failed to reach the forebay. During 2002, 47 percent of the fish that entered the reservoir were never detected in the forebay–a three-fold increase over 2001. Conversely, by not accounting for some fish that would have remained in the river reach had they been released above Station 1, the proportion of fish entering the reservoir that passed the dam in 2002 was underestimated.

2.5.5.3 Entrainment and Impingement at Fish Screens

Mirabel Diversion Fish Screens

Engineering design and critical operating parameters for the two fish screens at the Mirabel diversion mostly meet NOAA Fisheries criteria for juvenile salmonids. Although there are some small areas on the screens with approach-velocities higher than NOAA Fisheries criteria, particularly on the upstream screen, the risk to juvenile salmonids is low. The opportunity for entrainment based on the proportion of flow diverted is moderate; between 25 to 50 percent of water flow is diverted when juvenile fish are present. The Mirabel diversion operation normally does not overlap significantly with the juvenile outmigration period of coho salmon and Chinook salmon, but the overlap with steelhead is greater. However, because the screen is designed and operated mostly within NOAA Fisheries screen criteria for juveniles, the overall risk to all three species is low.

Because the Mirabel screen design is not within NOAA Fisheries criteria for salmonid fry (juvenile fish less than 60 mm long), there is a higher risk of entrapment, impingement, or injury to fry of all of the three species that may be present. The risk for steelhead fry is slightly higher than other species because the diversion operation period is most likely to overlap with the steelhead fry rearing period. However, optimal spawning habitat does not exist in the area, and rearing habitat is limited during the warmest summer months. Therefore, while some fry may be at a high risk for entrapment, impingement, or entrainment, the overall risk to the populations of listed species is probably low.

Wohler Diversion Fish Screens

Wohler diversion screen design and operation are not within NOAA Fisheries criteria for juvenile or fry. Young fish that are exposed to the facility have a high risk of entrapment, impingement, injury, or migration delay. In some years, the diversion may be operated earlier or later than the normal May to November period. However, the diversion is normally operated during a small portion of the coho salmon and Chinook salmon outmigration period, and a larger portion of the steelhead outmigration period (about 40 percent overlap). The risk is somewhat reduced because only about five percent of total river flow is diverted at Wohler. Combining these two components, juvenile coho salmon and Chinook salmon are at a low-to-moderate risk for entrapment, impingement, injury, or migration delay, primarily because the Wohler diversion operation does not overlap significantly with the juvenile outmigration period. The risk for steelhead entrapment, impingement, or injury is higher, based on a greater overlap with diversion operation and juvenile outmigration period, and therefore, steelhead juveniles are at moderate risk.

2.5.5.4 Overtopping at Mirabel and Wohler Ponds

Flood flows periodically overtop the river bank and flood the Mirabel and Wohler infiltration ponds. When floodwaters recede, fish may be entrained in the ponds.

Mirabel

Potential effects to listed fish species were evaluated in *Interim Report 4* (ENTRIX, Inc. 2001a). Of 35 water years modeled, Mirabel ponds would have overtopped 28 days or about 0.1 percent of the time. The months during which the ponds would have overtopped are December through March. Because the ponds at Mirabel do not overtop often, the opportunity for entrainment at Mirabel during high flows is small. Although the portion of surface water that enters the Mirabel infiltration ponds during flooding has not been measured, it is estimated to be less than five percent of the flow.

Because less than five percent of streamflow during flood events enters the Mirabel ponds, and the ponds overtop during only a very small portion of the steelhead juvenile migration period, steelhead are subject to low risk. Coho salmon and Chinook salmon juveniles are more likely to migrate through the area when the ponds overtop. They would be subjected to a moderate risk of entrapment or migration delays. However, the ponds do not overtop very often; thus, individual fish may be affected but the overall risk to the populations is low. Chinook salmon were found in the Mirabel ponds during rescue operations in 1998. Although some fish may be lost to injury or stress during rescue operations, rescue operations at the Mirabel infiltration ponds minimize the overall risk to the three listed fish species.

Wohler

The Wohler ponds are at a greater risk of being overtopped and flooded by the river than the Mirabel ponds. Computer simulations estimate that Wohler pond No.1 would have overtopped 533 days over 35 years, or about four percent of the time, and Wohler pond No. 2 about 625 times (5 percent of the time). The Wohler ponds flood almost every year. In general, flooding occurs during November through April. Although the portion of the surface water that enters the pond during flooding has not been measured, it is estimated as less than five percent of the flow. The Wohler ponds are relatively small (1.7 acres combined), so it is assumed that only a small portion of the mainstem flood flow enters the ponds.

2.5.5.5 Stranding or Displacement from Flow Fluctuation

When the inflatable dam is raised or lowered, water levels downstream or upstream, respectively, of the dam can drop, creating an opportunity for stranding juvenile fish downstream or upstream of the dam. Some stranding of warmwater fish has been noted upstream of the dam, but not of salmonids.

When the inflatable dam is lowered, stranding or displacement of salmonids due to dewatering effects could occur in two miles of river upstream. Generally, habitat in the reach that is affected by impounded water does not have characteristics conducive to stranding. The channel is primarily run-habitat with fine gravel, cobble, and boulder substrates. It is a single channel river that has a relatively straight trajectory through the area and relatively few structural features that would create low areas outside the main channel. The slopes of the river margins have a low gradient, but are sloped to the main channel. The wetted channel extends from bank to bank whether the dam is inflated or deflated, so it is unlikely that dewatering of the riverbed is a concern.

Deflation of the dam is almost always in response to rising river flow, which results in an attenuation of stage change and in no net dewatering of habitat. The attenuated stage change within the impoundment behind the inflatable dam is small enough that there is generally a low risk of stranding for juvenile salmonids. The dam is not lowered frequently (on average less than two times per year), the channel shape presents little risk of stranding, and dewatering of the riverbed is unlikely. Therefore, deflation of the inflatable dam presents a low risk of stranding to juvenile salmonids if it is done slowly enough. However, stranding of warmwater fish species has been observed when the dam has been deflated too quickly.

2.5.5.6 Temperature

When the inflatable dam impounds water, water temperatures may increase. Similar effects may occur related to deepening areas of gravel bars downstream of the dam. The inflatable dam operation is basically a run-of-the-river operation, and preliminary data suggest there is only a slight increase in water temperature through the Wohler Pool (0.5°C). A five-year monitoring study will produce data to further assess any potential effects. Steelhead rearing may occur in the area, but coho salmon are thought to use the area solely for passage. Chinook salmon juveniles migrate out by the end of June. By summer, temperatures in the inflatable dam impounded area, as well as free-flowing areas above and below the dam, are warmer than published water temperature criteria for salmonids. This small increase in temperature (0.5°C) is not likely to affect smolts migrating through the area, but may slightly reduce the quality of rearing habitat present during the early summer.

2.6 ESTUARY

The Russian River Estuary extends six to seven miles from the river's mouth at the Pacific Ocean, near Jenner, upstream to Duncans Mills and Austin Creek in western Sonoma County (Figure 2-25). On occasion, tidal influence has occurred as far as 10

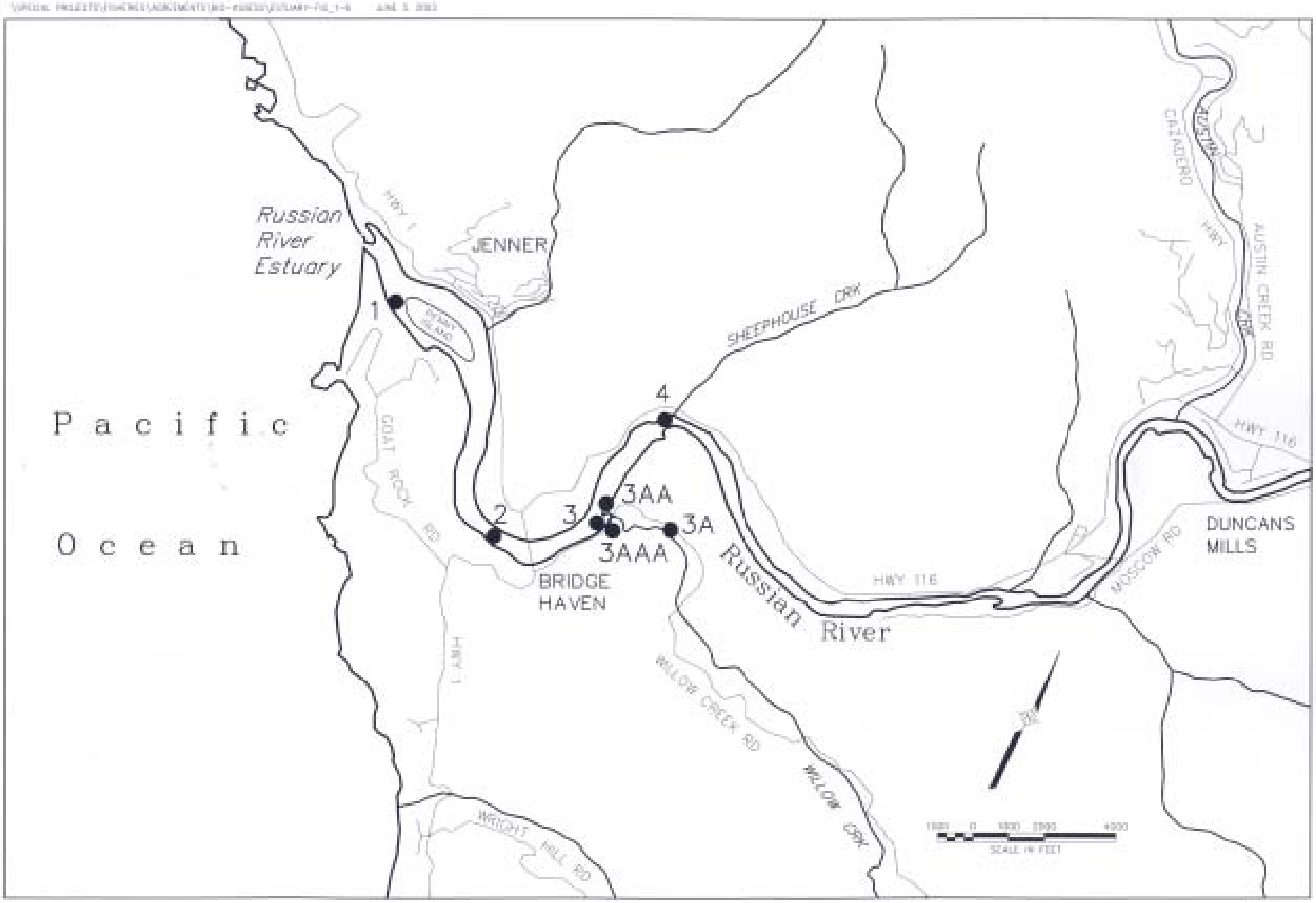

Figure 2-25 Map of Russian River Estuary Showing Biological and Water Quality Monitoring Sample Sites

miles upstream to Monte Rio (RREITF 1994). A barrier beach (sandbar) occasionally forms naturally across the mouth of the river during the dry season (and may also occasionally form during winter months), impounding water and forming a lagoon. The sandbar opens naturally when hydraulic conditions in the Russian River and Pacific Ocean change, or when it is artificially breached. When the sandbar is open, the Estuary is open to tidal mixing.

Current project operations affect the Estuary primarily in the low-flow months when minimum instream flow requirements under D1610 augment flow to the Estuary. These augmented flows result in a need for an artificial sandbar breaching program to prevent flooding of local property.

2.6.1 Current Conditions and Management Activities

Before the current breaching program was conducted by SCWA, the Sonoma County Department of Public Works would breach (i.e., open) the sandbar at the mouth of the Russian River when it closed and caused flooding of low-lying areas surrounding the Estuary. On occasion, the sandbar was also breached by local residents. Resource managers became concerned that indiscriminate breaching of the sandbar was affecting the Estuary ecosystem. Following a study of the effects of artificial breaching (RREITF 1994), a Management Plan was adopted by the Sonoma County Board of Supervisors. Following the adoption of the Management Plan, SCWA assumed responsibility from the Sonoma County Department of Public Works and began implementing the plan, including any needed revisions based on monitoring studies. A monitoring program was initiated to evaluate the effects of breaching the sandbar during the period from 1996 to 2000 (Merritt Smith Consulting [MSC] 1997a-b, 1998, 2000, SCWA 2001b).

The current Management Plan for the Estuary includes:

- **Breaching of the Sandbar.** The sandbar is breached using a bulldozer when water levels in the Estuary exceed 4.5 feet at the Jenner gage. SCWA’s goal is to breach by 7.0 feet at the Jenner gage. Water levels are determined from an automated tide recorder. The maximum water elevation was selected to minimize the discharge of anoxic water from Willow Creek Marsh into the Estuary, avoid high flushing velocities caused by high water elevations in the Estuary prior to breaching, and prevent the flooding of property. The breaching schedule varies from year to year depending on the frequency of closure of the Russian River mouth. There is no clear pattern of closures and breachings, but late fall and early spring closures are typical.

- **Automated Tide Recorder.** An automated tide recorder has been installed at the Jenner Visitor’s Center. Data from the tide recorder are displayed at SCWA’s Operations Center in Santa Rosa by remote telemetry.

  Biological and Water Quality Monitoring. Biological and water quality monitoring was conducted before, during, and after four-to-seven mechanical breaching events per year. Because monitoring was tied to breaching events, sandbar-open conditions that may be maintained naturally in the early part of the summer were not monitored. Data were collected at seven sample sites in the Estuary (Figure 2-25, Table 2-18). Water quality was also sampled at sites along Willow Creek. At each site, fish and invertebrates were sampled with a seine and otter trawl, while water temperature, DO, and salinity were measured with water quality instruments. Pinniped behavior was monitored at the Russian River mouth by visual observations.

Table 2-18 Water Quality and Fish Sampling Monitoring Locations in 1999 and 2000

Year	Water Quality	Fish Sampling
1999	Datasondes @ Stations 3, 3AA, 4 Profiles @ Stations 1, 2, 3, 3A, 3AA, 3AAA, 4	Beach seines @ Station 1, 3 Otter trawl @ Stations 1, 2, 3, 4
2000	Datasondes @ Station 3, 3A, 3AA Profiles @ Stations 1, 2, 3, 3A, 4	Beach seines @ Stations 1, 3, 4 Otter trawl @ Stations 1, 2, 3, 4

The number of breaching events varies from year to year depending on the amount of inflow and beach and ocean conditions that determine the frequency of closure of the Russian River sandbar. For most of the years studied, sandbar closures and breachings were generally concentrated in the fall (Table 2-19). Under flow conditions regulated by D1610, the system is generally managed as an estuary (sandbar open) rather than a lagoon (sandbar closed). Artificial breaching is triggered by water surface elevation at the Jenner gage rather than by the length of time the sandbar is closed. With the current level of artificial breaching effort, the bar-closed times are generally limited to 7 to 10 days, although occasionally they are longer (MSC 2000).

2.6.1.1 Water Quality

Water temperature in the mainstem Russian River has been considered the limiting factor affecting salmonid rearing habitat. However, below RM 10, coastal fog and other marine influences have a minor cooling effect on surface water. The coastal river zone may provide better conditions for salmonids including cooler summer temperatures (Winzler and Kelly 1978).

The five-year monitoring study collected water quality data before, during, and after artificial breaching events at one-meter-depth intervals in the water column at sites between the river's mouth and Sheephouse Creek. Water quality profiles were generally taken in the afternoon, so diurnal changes were not recorded. Additionally, datasondes (instruments used to record hourly temperature, salinity, and DO) were deployed on the bottom in deep pools in the Estuary and in Willow Creek throughout the study season (Figure 2-25).

When the sandbar closes the river mouth, it traps saltwater in a lagoon. Because saltwater is denser than freshwater, it forms a layer under the freshwater from the river

Table 2-19 Summary of Sandbar Closures and Artificial Breachings, 1997 to 2000

Date Closed	Days Closed	Date Breached	Gage Height[1]	Days Open
1996				
June 29	5	July 5		
July 24	11	August 3[2]		
August 23	5	August 27[2]		
		September 8[2]		
September 14	12	September 26		
October 7	8	October 15		
		November 6 (N)[3]		
1997				
March 30	1	March 31		18
April 18	5	April 23 (N)[3]		12
May 2	1	May 3 (N)[3]		12
May 15	7	May 22		11
June 2	7	June 9		7
June 16	11	June 26		44
August 9	10	August 20		19
September 9	10	September 19		7
September 26	3	September 29		4
October 3	8	October 11		15
October 26	8	November 3		4
November 7				
1998				
August 26	4	September 1		6
September 7	5	September 12		1
September 13	1	September 14		9
September 23	5	September 28		7
October 5	3	October 8		7
October 15	4	October 19		4
October 23	4	October 27		1
October 28	1	November 2		
1999				
June 12[4]	3	June 15	7.4	6
June 24	6	July 1	6.3	78
September 17	7	September 23	6.6	2
September 25	8	October 4	7.0	3
October 7	14	October 15, 21[5]	6.7, 7.44	9
November 1	3	November 4(N)[3]	5.7	2
November 6	4	November 10	8.9	3
2000				
May 7	2	May 9	8.46	37
June 16	5	June 21	6.90	67
August 28	8	September 5	7.62	31
October 7	4	October 11	6.54	12
October 24	3	October 27	6.87	7
November 4	3	November 7	6.93	2
November 10	3	November 13	6.74	7

Table 2-19 Summary of Sandbar Closures and Artificial Breachings, 1997 to 2000 (Continued)

Date Closed	Days Closed	Date Breached	Gage Height[1]	Days Open
November 21	3	November 24	7.34	2
November 27	3	November 30	7.73	2
December 3	3	December 6	7.69	20
December 27	2	December 29	7.10	4

[1]Height on tide gage immediately before breaching.

[2]Unauthorized breach by unkown persons.

[3]Natural breach.

[4]Sandbar closed completely on June 12, but was partially closed for at least 9 days before that.

[5]Sandbar was breached October 15 but closed again the following day. Sandbar was breached again on October 21.

(stratification), forming a saltwater lens that traps heat. Salinity, temperature, and DO stratification occur within the water column. Through natural processes, DO becomes depleted in the bottom saline layer and anoxic conditions develop.

When the sandbar closes, salinity stratification leads to reductions in DO and increases in temperature in the near-bottom layers of deep pools within the first two weeks. When the sandbar is breached, tidal mixing can contribute to a renewal of DO and reduced temperatures. This process occurs most quickly near the mouth of the river, but may take several days at upstream sites. The rate of change is influenced by the volume of river flows, whether there is a spring tide or neap tide, and the length of time the sandbar remains open. When the sandbar re-forms, salinity stratification again leads to a deterioration of water quality in deep pools.

In general, oxygenated freshwater occurred near the water surface, while salinity levels near 30 parts per thousand (ppt) with low DO occurred near the bottom. The deepest pools often remained stratified until an influx of tidal flows or higher winter flows flushed the pools or caused mixing of the stratified layers. Summer breaching of the sandbar draws freshwater through the Estuary and accelerates mixing of stratified layers in the pools, which increases DO at depth. However, flows caused by breaching may not be sufficient to mix saline waters located at the bottom of the deepest pools.

Water quality monitoring in the water column often documented stratified conditions. In a pre-breaching survey on June 30, 1999 at water quality monitoring Station 2 (Figure 2-25), surface waters were 24°C, but in the subsurface layer, with a very high DO spike (probably related to photosynthetic plants), water temperatures were between 15 and 20°C (MSC 2000). A survey on July 6 during tidal conditions revealed a similar temperature and salinity profile, but DO was more uniform from surface to bottom at levels between approximately 6 mg/l and 8 mg/l. Water quality in near-bottom layers of pools appeared to be better when the sandbar was open than when it had been closed for a couple of weeks. The sandbar is breached frequently under the management plan. This may help to reduce the duration of low DO and high temperature conditions in the Estuary.

Water quality is influenced by tidal intrusion of saltwater and stratification of the water column in the lagoon. In general, fluctuations in salinity levels in the Estuary are dampened during closures of the river mouth, while daily water temperature fluctuations increase during periods when the mouth is open. Salinity levels of approximately 30 ppt have been recorded as far upstream as Sheephouse Creek, approximately 3.1 miles upstream of the river mouth. Salinity at this level is similar to ocean water. Typically, there is little or no saltwater intrusion into the Estuary when freshwater flows are sufficient to maintain a mouth opening. A possible exception is during periods when tides exceed 6 feet National Geodetic Vertical Datum (NGVD).

Water quality is affected by the schedule of artificial breaching, but is not completely determined by it. Water quality monitoring in the Estuary found that the renewal of DO in the saline near-bottom layers of deep pools is mediated by both river flow and tidal action (spring/neap cycle) as well as by post-breaching flushing (MSC 2000). While low DO in the near-bottom layers of the deep pools is associated with sandbar-closed conditions, anoxia can also develop under tidal conditions during neap tides and/or low river flows (MSC 2000).

Some datasonde water quality data collected in 1999 are presented to illustrate general processes in the Estuary (MSC 2000). Additional data are available in reports from five years of monitoring (MSC 1997a-b, 1998, 2000, SCWA 2001b). The data show that when the sandbar remains open, water quality is generally better in the near-bottom layers than when it has been closed for a short time. It should be noted that datasonde monitoring may give a general assessment of water quality changes in these deep pools, but does not assess the extent of microhabitat elsewhere that may provide refugia for salmonids. Furthermore, this study only monitored water quality during short periods of sandbar closure. If the lagoon were to stay closed for a longer period, the lagoon would be expected to convert to freshwater and water quality could improve.

During summer 1999, the sandbar closed twice in June, but then remained open for the next 78 days (July to mid-September) (Table 2-19). The bar was breached five times in September, October, and November. This pattern of sandbar closure and breachings concentrated in the fall was similar to other years studied except 1997, when closures first occurred in late March. Therefore, data collection from breaching surveys has been concentrated in the fall.

At water quality monitoring Station 3 at the mouth of Willow Creek, temperatures in the near-bottom layer of the monitored pool were suitable when the sandbar was open, and DO levels fluctuated, generally increasing during spring tides and decreasing during neap tides (MSC 2000). After the sandbar closed on October 7, 1999, DO decreased steadily from between 6 and 7 parts per million (ppm) during a 14-day closure, and anoxia was reestablished in the bottom layers of the pool by October 18 (within 11 days). During two brief November closures (3 and 4 days long), DO levels declined, from approximately 5 ppm to very low levels, but anoxic conditions did not form in the near-bottom layer.

In contrast, at water quality monitoring Station 4, the most upstream monitoring site, near-bottom anoxia was not relieved until five days after a June 15 breaching. This occurred during neap tides at a river flow of 260 cfs. When the sandbar closed on June 24, near-bottom DO gradually declined during a 6-day closure, and continued to decline for several days after the July 1 breaching. Highest DO values were usually associated with spring tides (MSC 2000).

Water quality monitoring often showed stratified conditions in the water column. In a pre-breaching survey on June 30, 1999 at water quality monitoring Station 2, surface waters were approximately 24°C, but in the subsurface layer, with a very high DO spike (probably related to photosynthetic plants), water temperatures were between 15 and 20°C. A survey on July 6 during tidal conditions revealed a similar temperature and salinity profile, but DO was more uniform from surface to bottom at levels between approximately 6 and 8 mg/l. Water quality in near-bottom layers of pools appeared to be better when the sandbar was open than when it had been closed for a couple of weeks. The sandbar is breached more frequently under the Management Plan than it was previously, and this may help to reduce the duration of low DO and high temperature conditions in the Estuary.

2.6.1.2 Biological Resources

A total of 43 species of fish were collected in the Estuary during the five years of the monitoring study (MSC 1997a-b, 1998, 2000, and SCWA 2001b). Commonly captured estuarine/marine species included topsmelt, Pacific sanddab, starry flounder, staghorn sculpin, prickly sculpin, threespine stickleback, and shiner surf perch (Table 2-4). The distribution of marine fish is limited to the lower Estuary below the Willow Creek mouth, with the most salt-tolerant species found only near the Russian River mouth.

Commonly captured freshwater fish included Sacramento sucker, Sacramento pikeminnow, and California roach. These species tend to move down into the Estuary and Willow Creek marsh during the summer and return upstream in the fall. Macroinvertebrate species commonly captured in otter trawls included opossum shrimp (*Neomysis mercedis),* bay shrimp (*Crangon franciscorum*), dungeness crab (*Cancer magister*), amphipods (*Eogammarus confervicolus*), and spaeromatid isopods (SCWA 2001b).

The upper portions of the Estuary, which have not been sampled, may also be important for juvenile-rearing salmonids if water quality is suitable, especially since a coastal fog belt moderates high water temperatures in the summer. Data from the Mirabel sampling program indicate that naturally spawned juvenile Chinook salmon migrate down the Russian River in the spring (Chase et al. 2000). Fall-run Chinook have been known to rear in estuaries before going to the ocean (Kjelson et al. 1982) and may rear for a time in some part of the Estuary. The tributaries in the lower Russian River contain high-quality steelhead spawning and rearing habitat. Although steelhead rear in freshwater throughout the year, they have been caught in the Estuary and may make use of suitable portions of the Estuary (MSC 2000).

Biological sampling, which has been conducted around artificial breaching events, has been largely concentrated in fall months, and therefore was not designed to assess how salmonids may use the Estuary throughout the year. In 1997, when fish sampling occurred earlier in the year, steelhead were captured throughout the summer, and three-year classes appeared to be represented (MSC 1997a). Steelhead were captured during all five years sampled. Chinook salmon were captured in 1992, 1993, 1997, and 1999 in the early spring when migration occurs (RREITF 1994 and SCWA 2001b). Coho salmon also pass through the Estuary, but have not been captured during sampling for the Management Plan. Most adult salmonids migrate up the Russian River during the period when the mouth is naturally open, usually late fall to early spring.

Pinnipeds use the sandspit at the river mouth as a haulout and to forage for fish, including listed species. Harbor seals, sometimes numbering in the hundreds, regularly use the Russian River mouth year-round, while California sea lions and elephant seals occur periodically in low numbers. Harbor seal numbers peak in the late winter and mid-summer and prefer to use the river's mouth when it is open.

The capture rate of salmonids by seals may be affected by the width of the breach opening and river flows during fish migration periods. A mechanical breach with a wide opening and ample flows increases passage for outmigrating juveniles and returning adults through the river mouth and may reduce the potential for seals to capture salmonids. Seals have been observed foraging in the Estuary and are more successful at capturing fast-moving prey, such as salmonids, if they can take advantage of trapped or stressed fish. In 1992, outmigrating juvenile salmonids consisted of 17 percent of the prey items of harbor seals when the mouth was closed, compared with 5 percent when the Estuary was open (RREITF 1994). However, this predation rate may not have been representative of typical conditions. Prior to the predation study, rainfall had increased flows in the Russian River, the sandbar and the river mouth had closed the Estuary, and 36,000 salmonid smolts were released from the DCFH located upstream from the Estuary.

2.6.1.3 Willow Creek

In 1992, a fish (prickly sculpin) and invertebrate (mysid) kill at the mouth of Willow Creek was associated with a flush of anoxic water from Willow Creek after the sandbar was breached after water levels reached over 9 feet (RREITF 1994). This kind of event has not occurred during the five years of monitoring the Estuary. Mortality of prickly sculpin in 1998, associated with a breaching event after water levels rose to 8.2 feet, may have been caused by low DO in water draining from Willow Creek, but no anoxia was detected (MSC 1998). Dead dungeness crabs were found in 1999 near the mouth of Willow Creek, but this was most likely due to a flush of freshwater after an artificial breaching event (MSC 2000).

The 1992 and 1998 high-mortality events were associated with breaching events that occurred at over 9.0 feet and 8.2 feet, respectively. Artificial breaching events associated with water levels lower than 8.0 feet did not result in similar events. When water levels were greater than 8.0 feet, near-bottom DO levels at the monitoring sites became anoxic within a few days of sandbar closure. Currently, artificial breaching is initiated when the water level reaches 7 feet at the Jenner gage, to reduce the risk of flushing anoxic water from Willow Creek.

The 1992 event was believed to occur because a large area of Willow Creek marsh became inundated and then became anoxic due to low water inflow and high biological oxygen demand (BOD) (RREITF 1994). Another explanation could be that when the sandbar is breached at higher water surface elevations, higher flushing flows are more likely to discharge bottom waters and sediments containing low DO levels.

2.6.2 Factors Affecting Species Environment within the Estuary

The Estuary is important for adult and juvenile passage for all three listed species. When juvenile salmonids become smolts, they undergo a physiological change that allows them to make a transition from freshwater to saltwater. An estuary provides an opportunity for smolts to gradually become acclimated to ocean conditions before their migration out of the river system. Estuaries and lagoons can also provide important rearing habitat for steelhead and Chinook salmon. Coho salmon are not thought to use the Russian River Estuary for rearing (either historically or at present) because available evidence indicates that most rearing takes place in riverine pool- and run-habitats that are typical of tributary stream reaches.

Augmented summer flows have the potential to affect several components of salmonid habitat in the Estuary. These include water quality (including temperature, DO, and salinity), primary productivity and the availability of aquatic invertebrates, availability of shallow-water habitat, and the concentration of nutrients and toxic runoff. The breaching program may also affect these components.

The artificial breaching program has the potential to affect adult salmonid upstream migration and juvenile downstream migration by creating additional passage opportunities. Since adult Chinook salmon congregate at the mouth of the river as early as mid-August, artificial breaching is of particular concern for this species. If the sandbar is breached before rising river flow from winter storms improves water quality in the mainstem Russian River, adult Chinook salmon may become trapped in poor quality water. The risk of predation on listed fish species may be increased when migrating juvenile salmonids are concentrated into a channel through the sandbar, and when pinnipeds are attracted to the breached sandbar.

Estuaries and coastal lagoons have been found to provide important salmonid rearing habitat in coastal lagoons in the southern portion of the CCC steelhead ESU (Smith 1990) and elsewhere (Larson 1987, Anderson 1995, 1998, 1999, Reimers 1973). If the sandbar of one of these central California estuaries remains open, good water quality can be maintained with tidal mixing or high river flows. In a lagoon (sandbar-closed), suitable water quality develops when the system is converted to freshwater, which results in lower water temperatures and higher bottom-DO levels. Infrequent breaching of these lagoons, especially during low-flow summer months, impairs water quality because a long transition period with salinity stratification results in high water temperatures and low DO levels (Smith 1990). After the sandbar opens, there is a period of rapid transition when habitat and water quality changes dramatically. After these transition periods, the flora and fauna of the estuary undergo dramatic changes in response to the changed environment.

Rapid or fluctuating changes in salinity and water level in small coastal lagoons can have substantial effects on the invertebrate foodbase for fish. Smith (1990) found that when sandbar formation resulted in anoxic conditions over the majority of the substrate, amphipods were eliminated from those areas, and invertebrate populations crashed as the lagoons went through the transition to freshwater. Once these lagoons had converted to freshwater conditions, invertebrate populations became sufficiently re-established to result in accelerated salmonid growth. Continuous breaching, such as occurred at San Gregorio lagoon in the summer of 1986, resulted in low overall invertebrate populations as the system fluctuated between anoxic saline and freshwater conditions.

Sandbar breaching may also influence habitat and water quality in Willow Creek marsh. Water quality monitoring showed that DO in the marsh decreased following sandbar closure, possibly because terrestrial vegetation becomes submerged and begins to decay, increasing BOD during a time when water flow into the marsh is insufficient to renew DO levels. Fluctuating water levels may create conditions that are different from those that would be found in a stable marsh, where aquatic vegetation has time to establish and renew DO in the wetted portions of the marsh.

Augmented flow in the Russian River Estuary has several beneficial effects. It may slow the development of poor water temperatures and DO levels after the sandbar closes. Agricultural and urban runoff and treated sewage discharges from throughout the watershed may increase nutrient loads and chemical levels in the Estuary. Augmented summer flows help to dilute these constituents and carry them out of the Estuary when it is open.

The need to breach the Estuary in the dry season to prevent local flooding probably reduces the value of the Estuary for rearing. This frequent breaching may have harmful effects that reduce the somewhat beneficial effects by causing continually changing habitat conditions (depth, salinity, temperature, and DO) in portions of the Estuary. While salmonids are highly mobile and can move away from these areas, most of their foodbase is not as mobile and may experience population fluctuations during repeated breachings. The reduction of this foodbase may thereby reduce the suitability of the Estuary for juvenile salmonids.

With D1610 flows under projected 2020 water demands, flows to the Estuary would be reduced by 20 to 30 percent from June through November in *normal* water supply conditions. This may result in the need to breach the Estuary less frequently. Infrequent summertime breaching has been shown to degrade rearing habitat for salmonids in coastal lagoons (Smith 1990).

2.7 CHANNEL MAINTENANCE

SCWA conducts channel maintenance activities in the Sonoma County portion of the Russian River and its tributaries for the purposes of flood and erosion control. SCWA's scope of responsibilities include activities related to the Central Sonoma Watershed Project and the Mark West Creek watershed, channels near Healdsburg, and USACE dams on the East Fork Russian River (CVD) and Dry Creek (WSD).

The activities implemented by SCWA for flood control purposes in the Central Sonoma Watershed Project and Mark West Creek watershed include sediment removal, channel debris clearing, vegetation maintenance, and bank stabilization. The Zone 1A flood control zone is shown in Figure 2-26. SCWA's stormwater discharge activities in the Santa Rosa area are covered under RWQCB Order 81-73.

SCWA channel maintenance activities include the following:

1) Channel maintenance within the Central Sonoma Watershed Project and Mark West Creek watershed.

2) Russian River

   a. Channel maintenance related to the construction and operation of CVD.
   b. Channel maintenance related to USACE-identified and -constructed flood and erosion control sites (federal sites).
   c. Channel maintenance related to Public Law 84-99 sites (nonfederal sites).
   d. Debris removal as necessary to protect life and property.

3) Dry Creek channel maintenance related to the construction and operation of WSD (federal sites) and inspection of one nonfederal site (Public Law 84-99).

4) National Pollutant Discharge Elimination System (NPDES) stormwater discharge permit activities in the Santa Rosa area.

MCRRFCD conducts channel maintenance activities related to the CVDP in the Mendocino County portion of the Russian River. This includes channel maintenance related to federal sites and inspection of Public Law 84-99 (nonfederal) sites. MCRRFCD also conducts activities related to streambank erosion control in the Russian River.

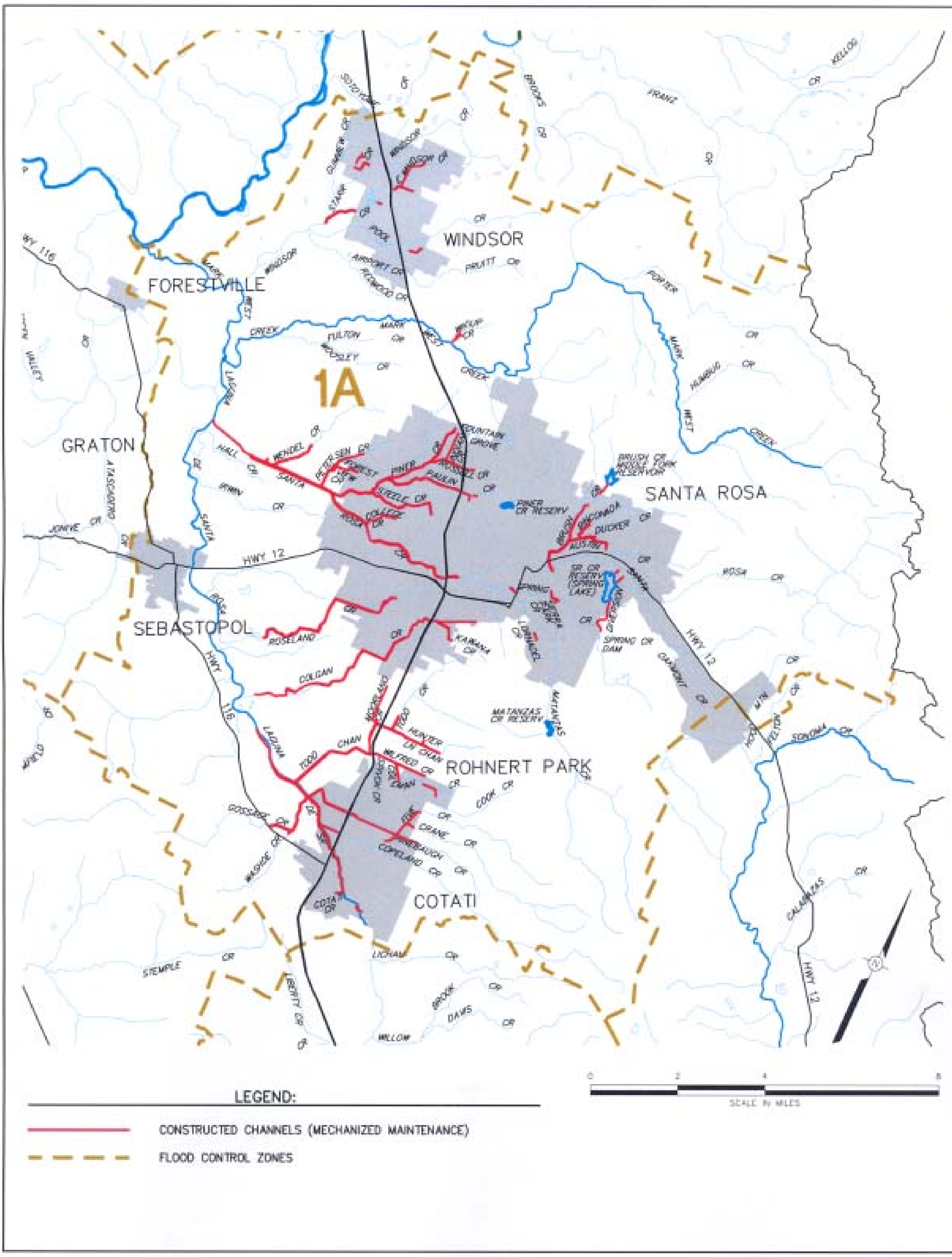

Figure 2-26 Zone 1A Constructed Flood Control Channels

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2.7.1 Central Sonoma Watershed Project

In addition to constructed flood control channels (discussed in the following section), the Central Sonoma Watershed Project includes four flood control reservoirs that were built in the late 1960s to reduce flooding in the Santa Rosa area. These four flood control reservoirs are located on Santa Rosa, Brush, Paulin, and Matanzas creeks. The Santa Rosa Creek Reservoir (Spring Lake) is located offstream. A diversion structure at the inlet allows relatively low flows to bypass the reservoir, routing the flow downstream into Santa Rosa Creek, while a portion of the higher flows are diverted into the reservoir. A diversion structure on Spring Creek also diverts water to Spring Lake. Other than the Santa Rosa Creek Reservoir, the other flood control reservoirs are situated onstream and are equipped with facilities (low-flow bypass and principal spillway) that allow minimum streamflows to be released. These reservoirs operate passively and are not equipped with flood control gates.

Facilities are not provided for anadromous fish passage above the instream flood control reservoirs or the diversion on Spring Creek. However, a fish ladder and vortex weir are located on Santa Rosa Creek to assist anadromous fish passage.

2.7.2 Natural Waterways and Constructed Flood Control Channels Maintained in the Russian River Watershed

SCWA conducts channel maintenance activities on approximately 300 miles of creeks within Sonoma County. Most of these streams are located in the Russian River watershed. The creeks include both natural waterways and constructed flood control channels.

Channel maintenance activities for these channels are discussed in this section. Channel maintenance activities related to the CVD and WSD projects in the Russian River and Dry Creek are discussed in the following section.

2.7.2.1 Constructed Flood Control Channels

Constructed flood control channels (many of which are part of the Central Sonoma Watershed Project) are widened and straightened waterways that have been significantly altered and improved based on flood control criteria (Table 2-20). The purpose of the improvements is to increase hydraulic capacity. SCWA either owns in fee the rights-of-way for constructed flood control channels, or holds a drainage easement on them. These channels generally include service roads to facilitate maintenance access.

Sediment removal was historically performed on an annual basis in the constructed flood control channels. Sediment removal is now conducted on an as-needed basis. Some of the constructed flood control channels require annual sediment removal, some require sediment removal approximately every two to five years, while some have never required sediment removal. Recent sediment removal activities on flood control channels have included Copeland, Colgan, Russell, Todd, Indian, Hinebaugh, and Roseland creeks, as well as the Cook Creek sediment basin.

SCWA performs routine vegetation maintenance for flood control purposes on approximately 150 miles of constructed flood control channels in Sonoma County. The access roads for the constructed flood control channels were historically kept clear of vegetation through the use of residual herbicides, which are effective for an extended period of time. Since the early 1990s, access roads have been cleared with residual herbicides, aquatic contact herbicides (which are effective only at the time of application [i.e., early spring]), and mowing.

Historically, SCWA was required to keep all vegetation on streambanks predominately grass with little or no tree growth. This represents baseline conditions. Since coho salmon were listed under the ESA, vegetation maintenance practices have been more limited.

Historically, the upper third of the channel bank was mowed to remove all grasses, bushes, and small trees. Since 1996, some vegetation as been allowed to develop and existing trees are maintained. Maintenance of the middle third of the channel bank has typically been limited to debris removal and light thinning of willow growth, as necessary.

Table 2-20 Constructed Flood Control Channels (Portions Thereof) Maintained by SCWA in the Russian River Watershed

Airport Creek	Forestview Creek	Paulin Creek	Starr Creek
Austin Creek	Gird Creek	Peterson Creek	Steele Creek
Brush Creek	Gossage Creek	Piner Creek	Todd Creek
Coleman Creek	Hinebaugh Creek	Redwood Creek	Washoe Creek
Colgan Creek	Hunter Lane Channel	Rinconada Creek	Wendell Creek
College Creek	Indian Creek	Roseland Creek	Wikiup Creek
Cook Creek Sediment Basin	Kawana Creek	Russell Creek	Wilfred Creek
Copeland Creek	Laguna de Santa Rosa	Santa Rosa Creek	Windsor Creek
Ducker Creek	Lornadell Creek	Sierra Creek	Woods Creek
Faught Creek	Norton Slough	Spivok Creek	
Five Creek	Oakmont Creek	Spring Creek	

Vegetation maintenance on the lower third of the channel bank, including the toe of the channel, was historically conducted on an annual basis. Recently, vegetation removal along the lower-third of the bank has been less frequently performed and is more selective, leaving some widely-spaced woody riparian growth, but preventing dense vegetation. Since vegetation removal practices were modified in the last several years, significant tree growth has occurred on many creeks such as Brush, Santa Rosa, and Hinebaugh creeks. The bottom of constructed flood control channels is cleared of vegetation, primarily willows/cattails and tule reeds, through hand clearing.

The original design of these channels assumed the 100-year-flood capacity could be maintained by keeping these channels free of sediment and most vegetation, except for grasses. A hydraulic assessment of selected Zone 1A constructed flood control channels was performed in 2000 to identify flood capacity under baseline management scenarios and to see if it has been impaired. Flood capacity under various vegetation maintenance practices were modeled (ENTRIX, Inc. 2002c) using USACE HEC-RAS. This assessment evaluated the channel maintenance needed to ensure that the design flow, typically a 100-year recurrence interval discharge (for drainage areas greater than 4 mi^2) can be safely passed. It should be noted that sediment deposition is another factor that can diminish hydraulic capacity, but this was not included as part of the model simulations, so interpretation of the results are based only on the influence of vegetation. Furthermore, not all channels were modeled, and hydraulic capacity of channels can only be definitively determined on a case-by-case basis.[8] However, most channels were originally designed with the expectation that there would be adequate flood capacity if vegetation was maintained primarily as grasses.

The following four vegetation maintenance scenarios were evaluated:

> *Original Design.* To maintain the 100-year flood (i.e., the design flow), it is assumed there is only low grass on the banks, no shrubs or trees are present, and the channel bed is assumed to be vegetation free. This represents the baseline condition upon which the channel designs were originally developed.
>
> *No Maintenance.* This scenario assumes full development of mature vegetation on the bed and banks, presence of dense woody vegetation, tall weeds, willows, shrubs, and trees. This scenario also assumes encroachment of vegetation from banks into the channel and dense aquatic vegetation on the bed. This condition would exist on many of the constructed flood control channels if all vegetation maintenance activities were to cease for at least 15 years.
>
> *Post-Maintenance.* The bottom five feet of bank above the channel bed has no more than a couple of year’s growth, allowing only scattered small shrubs and young willows (less than five feet tall). The rest of the bank above five feet from the channel bed is subject to thinning to prevent dense understory of willows, blackberries, and other shrubs. Existing mature trees are not removed, and banks may become moderately well-vegetated. The channel bed is near-original design condition; however, some encroachment of vegetation from banks and aquatic vegetation, primarily tules and grasses, establishes initially (up to two years growth). This scenario reflects some of the recent vegetation maintenance activities currently used by SCWA.
>
> *Pre-Maintenance.* This scenario describes the channel condition just prior to the post-maintenance activities. It assumes there will be a five-year cycle between the post-maintenance work periods so that there will be five years of vegetative growth on the bed and banks. The bottom 5 feet of bank above the channel bed will be expected to have moderately dense shrubs and many willows over 5 feet high. The rest of the bank height above 5 feet will have developed slightly more

[8] Hydraulic modeling was conducted on streams that represent a range of channel types, including Hinebaugh, Santa Rosa, Colgan, Five, Piner and Brush creeks.

dense vegetation than in the post-maintenance scenario. The channel bed is also expected to have five years of growth that allows tules, grasses, and a few scattered young willows to establish. However, observations indicate that active flow will maintain most of the channel bed free from dense vegetative growth (willows are unlikely to establish in standing water.)

This hydraulic assessment suggests that, other than Five Creek and possibly the few high-gradient, high width-depth ratio channels (for example Hinebaugh Creek upstream of Highway 101), most channels need some form of maintenance activities to keep vegetation from growing into a dense brushy stage to provide 100-year-flood capacity.

Table 2-21 provides a brief summary of findings.

Table 2-21 Summary of Findings, Hydraulic Assessment of Zone 1A Constructed Flood Control Channels under Various Maintenance Scenarios

Maintenance Scenario	Sufficient Capacity	Creek Evaluated
Original Design		
100-year flood	No	Santa Rosa Creek downstream of Willowside Bridge, Hinebaugh Creek Laguna de Santa Rosa confluence to near La Bath Bridge (4,000 feet), and one segment of Colgan Creek.
	Yes	All other channels evaluated.
10-year flood	No	Santa Rosa Creek downstream of Willowside Bridge.
No Maintenance		
100-year flood	Yes	Five Creek from Hinebaugh Creek channel to Snyder Lane, Hinebaugh Creek upstream of Snyder Lane to Hinebaugh Interception channel (3,000 feet), and a few high-gradient, high width-depth ratio channels.
	No	All other channels evaluated.
Post-Maintenance		
100-year flood	Yes	Almost all segments of Santa Rosa, Piner, and Hinebaugh creeks.
	No	Lowest segment of Hinebaugh Creek, and several short segments of Santa Rosa, Piner and Hinebaugh creeks.
25-year flood	Yes	Santa Rosa, Piner and Hinebaugh creeks.
Pre-Maintenance		
100-year flood	Yes	Hinebaugh Creek upstream of Highway 101 Bridge, and Five Creek.
	No	All other channels evaluated, including Santa Rosa Creek and Piner Creek downstream of Highway 101.

The post-maintenance scenario, which describes vegetation management practices in the 1990s, provides 100-year-flood capacity in most of Santa Rosa, Piner, and Hinebaugh creeks, but not always with sufficient freeboard. Therefore, site-specific areas may require vegetation maintenance that maintains original design capacity (baseline). Because 100-year flows are not contained in Santa Rosa Creek under the pre-maintenance scenarios, it will likely be necessary to perform maintenance more frequently than on the five-year cycle modeled, or to maintain the original design capacity. Santa Rosa Creek downstream of the Willowside Road Bridge was the only channel segment that had insufficient original design capacity to accommodate even the ten-year flood event. Only in Five Creek, and a portion of Hinebaugh Creek, will the pre-maintenance scenario provide capacity for the 100-year flow.

Except for a handful of bridges and culverts, most were capable of passing the 100-year discharge under pre- and post-maintenance scenarios. The culvert at Snyder Lane in Hinebaugh Creek appears to be the only location that cannot pass the 100-year flow under the original design and meet SCWA criteria for freeboard. The following bridges do not have the capacity to pass the 100-year discharge under either the pre- or post-maintenance scenarios, or both, and require the original design maintenance scenario.

Santa Rosa Creek	Stony Point bridge: pre- and post-maintenance Willowside bridge: pre-maintenance
Piner Creek	Hopper Ave. culvert: pre- and post-maintenance Fulton Road bridge: pre- and post-maintenance
Hinebaugh Creek	Snyder Lane: original, and pre-, and post-maintenance Redwood Ave. culvert: pre- and post-maintenance

A recent preliminary USACE study for the Santa Rosa Creek watershed that updates and re-evaluates rainfall and runoff conditions indicates that flood flows are of a higher magnitude than has been historically calculated and used to design flood control facilities (USACE 2002). SCWA is currently developing a more detailed study to evaluate the hydrology of the watershed and the hydraulic capacity of the flood control channels by examining and verifying several of the assumptions in USACE analysis. This study is part of the Santa Rosa Creek Ecosystem and Flood Damage Reduction Feasibility Study.

2.7.2.2 Natural Waterways

Natural waterways are waterways that have not been modified for flood control purposes by SCWA or USACE. SCWA holds permissive channel-clearing easements on many natural waterways in the Russian River watershed (Table 2-22).

Sediment removal is not performed on natural waterways. Occasionally, sediment and debris removal is conducted on natural waterways in response to an event such as a large storm. In recent years, this has included Austin and Big Sulphur creeks. These activities have been treated as emergency repairs. Based on past history, such activities occur about once every five to ten years.

Regular maintenance on natural waterways was historically performed with the objective of maximizing the hydraulic capacity without enlarging the waterways. In the 1970s to 1980s, SCWA staff used heavy equipment and hand crews with chainsaws to clear vegetation from the bottom of natural waterways. The use of heavy equipment ended in 1987, with clearing continuing to be performed by four-person crews using hand labor. Currently, no maintenance is performed unless SCWA elects to do so to protect adjacent property.

Table 2-22 Natural Waterways (Portions Thereof) Historically Maintained by SCWA in the Russian River Watershed

Atascadero Creek	Fife Creek	Laguna de Santa Rosa	Roseland Creek
Barlow Creek	Forestville Creek	Libreau Creek	Santa Rosa Creek
Blucher Creek	Foss Creek	Lower Russian River	Sheephouse Creek
Burton Ditch	Fountain Grove Creek	Mark West Creek	Spring Creek
Calder Creek	Fulton Creek	Matanzas Creek	Starr Creek
Coleman Creek	Green Valley Creek	Norton Slough	Steele Creek
Colgan Creek	Hartman Creek	Olivet Creek	Wikiup Creek
Copeland Creek	Hessel Creek	Paulin Creek	Wilfred Creek (N Fork)
Crane Creek	Hood Mountain Creek	Piner Creek	Willow Creek
Dry Creek	Hulburt Creek	Pocket Canyon Creek	Windsor Creek
Dutch Bill Creek	Jonive Creek	Rieman Creek	Woolsey Creek

2.7.3 Channel Maintenance Related to Construction and Operation of CVD and WSD

2.7.3.1 Coyote Valley Dam

SCWA and MCRRFCD were designated as the local agencies responsible for channel maintenance below CVD following completion of the dam. USACE provided MCRRFCD and SCWA with operation and maintenance manuals (O&M manuals) for Mendocino and Sonoma counties, respectively (USACE 1965a-b), and the *Water Control Manual for Coyote Valley Dam* (USACE 1986a). These manuals include procedures for operating the dam and maintaining the flood control improvements on the Russian River.

The Russian River naturally exhibits substantial meandering, erosion, and aggradation, which has caused problems near the channel maintenance sites since they were constructed. Operation and maintenance of these sites became the responsibility of local agencies after construction. Manuals provided by USACE (USACE 1965a-b) have provided guidelines for inspecting and maintaining the installed improvements on a yearly basis, or as needed, before, during, and after flood events.

In addition to channel improvements installed as part of the mitigation project for CVD, SCWA and MCRRFCD are responsible for inspecting certain channel improvement sites that were constructed between 1956 and 1963. The sites are located at various places in Sonoma and Mendocino counties, extending from RM 98 near Calpella to approximately RM 40 near Maacama Creek in Healdsburg.

2.7.3.2 Warm Springs Dam

Channel improvements at 15 sites along Dry Creek were built by USACE between 1981 and 1989 as part of the WSD and Lake Sonoma Project. The improvements include three rock-type grade-control structures, 5,800 feet of riprap bank protection, and flow-deflection fences. These improvements were intended to provide bank and riverbed stabilization at sites where erosion previously occurred or where studies indicated that future erosion was likely, due to the construction and operation of WSD. Maintenance responsibility for the channel stabilization project lies with SCWA, as established by an agreement between SCWA and USACE developed in June 1988. USACE provided to SCWA the *Warm Springs Dam and Lake Sonoma Project, Russian River Basin, Dry Creek Channel Improvements, Sonoma County, California Operation and Maintenance Manual* (WSD O&M Manual) (USACE 1991). This manual provides information, instruction, and guidance to the personnel responsible for proper operation, inspection, and maintenance of channel improvements and bank stabilization measures along Dry Creek downstream of WSD. Specific works are identified in the WSD O&M Manual.

Maintenance work associated with these sites can involve incidental sediment, vegetation, and debris removal, and also bank stabilization to insure the structural integrity of the improvements. Outside of the work done on the 15 channel improvement sites in Dry Creek, additional vegetation removal for flood control or bank erosion is not performed in Dry Creek by SCWA or USACE.

Inspections are performed on the one nonfederal levee (Public Law 84-99) on Dry Creek and the property owner is informed of the needed repairs.

2.7.3.3 Bank Stabilization on the Russian River and Dry Creek

Bank stabilization activities by SCWA and the MCRRFCD on the Russian River and its tributaries are limited to maintenance of past channel improvement projects, several of which were implemented by USACE on the Russian River, and for which SCWA and the MCRRFCD are the local sponsoring agencies responsible for maintenance.

Examples of bank stabilization structures previously installed and now maintained, as necessary, include anchored steel jacks in single and multiple rows, flexible fence training structures, wire mesh and gravel revetments (i.e., retaining wall), and pervious erosion check dams. Anchored steel jacks, used in bank protection, are used to prevent streambanks from undercutting. The jacks are ¼-inch angle iron with 16-foot legs, cabled together and anchored to the streambank on the ends. Pervious erosion check dams consist of gravel and wire mesh, and are used to control sheet erosion on streambanks. Many of the channel improvements described above were implemented to prevent erosion and provide bank stabilization. Many have been covered with soil, brush, and trees, and continue to provide the protection they were designed for with little or no maintenance needed.

The channel improvement areas and levees are inspected periodically by SCWA, MCRRFCD, and USACE. USACE then recommends maintenance work that may be needed. If the need for repairs is identified, those repairs are implemented and described in the annual reports to USACE.

In the Russian River, SCWA and MCRRFCD generally keep the project levees free from vegetation, removes instream gravel bars that may be impeding flow, and inspects and maintains the channel improvement sites. Typical maintenance recommendations for the channel improvement sites have included removing loose anchor jacks from the river, adding bank erosion protection, managing vegetation to reduce blockage of the river channel and increase access for maintenance and inspection of the banks, repairing or replacing loose grout or riprap, and removing driftwood. In recent years, SCWA has performed only limited maintenance activities in these areas due to concerns about potential effects to ESA-listed fish species.

SCWA and MCRRFCD are also responsible for inspecting certain levees along the upper Russian River under a program administered by USACE (PL 84-99). Inspections and small repairs to these non-project levees (nonfederal sites) have typically been performed by SCWA. If major repairs are needed, the property owner and USACE are notified.

MCRRFCD performs streambank maintenance in the Russian River in Mendocino County that consists of obstacle removal, streambank repair, and preventive maintenance. Because most bank erosion is caused by the river being directed into the riverbank by obstacles within the banks, most of the maintenance work is directed toward the removal of these in-channel obstacles. MCRRFCD assesses approximately one-third of the length of the river channel in Mendocino County each year, and works on sites identified within that area.

In Mendocino County, the summer flow, or low-water, channel is approximately 25 percent of the width of the winter flow, or high-water channel. The summer flow channel typically meanders from one side of the high-water channel to the other. In this configuration, willows have a tendency to take root on the inside bend of the low-flow channel during the summer and collect gravel during the ensuing winter. Bars tend to form as vegetation develops, creating low-velocity zones that encourage sediments to deposit. If left unchecked, this process continues until a willow-reinforced bar has developed to a size that is sufficient to divert the river into the high-water streambank, causing extensive bank erosion and river siltation. MCRRFCD has stated that, if left unchecked, the bars can, and have, developed into 10-feet high, 1,000-feet long, willow-covered deposits that obstruct and divert winter high-flows and increase the risk of bank erosion. This same condition exists in the Alexander Valley of Sonoma County.

MCRRFCD has maintained the river channel by removing willows from bars that develop as obstacles to high-water flows. Willow growth is controlled before a substantial bar can develop within the low-velocity waters created by the willows. If a riverbank failure occurs, the eroded bank material is often used to re-establish the high-water riverbank. Willows removed from bars are pushed against the bank where they take root and provide erosion control as well as riparian enhancement. This maintenance work is normally done at the end of the summer during low-flow conditions. This work has been performed with as little invasion into the stream channel as possible.

Major channel work has been performed by MCRRFCD in the past. Thousands of yards of gravel have been pushed up against the banks in an effort to provide bank stabilization and eliminate channel braiding. Currently, CDFG recommends actual removal of the gravel; however, MCRRFCD has not found removal of the gravel to be feasible.

Historically, extensive vegetation and sediment maintenance activities were conducted in the Russian River. Since coho salmon were listed under the ESA, these activities have been much more limited. Due to ESA considerations, USACE permits have not been issued for some activities. However, the activities described above represent baseline conditions.

2.7.4 Gravel Bar Grading in the Wohler and Mirabel Area

Infiltration capacity at the Wohler and Mirabel diversion facilities is augmented by periodically recontouring gravel bars in the Russian River upstream of the inflatable dam. Protocols for this activity may differ from those conducted for channel maintenance, so these activities are discussed separately.

SCWA currently conducts grading at four bars in the Mirabel and Wohler areas. Three of the bars are upstream of the inflatable dam and are referred to as the Bridge Bar, Wohler Bar, and McMurray Bar. The bar at Mirabel is the Mirabel Bar. The McMurray and Mirabel bars are approximately 1,000 feet long and 200 feet wide. The other two gravel bars are about 500 feet long and 100 feet wide.

Gravel bar skimming operations are performed on the Wohler, McMurray, and Bridge gravel bars in the spring of each year when streamflows drop below approximately 800 cfs, and before the dam is inflated. This work is performed at various times, depending on the flow in the river and demands on the water system, but the work is generally performed between March and July. The Mirabel gravel bar is skimmed between July and October, depending on flow conditions. Gravel at these locations is generally pushed up on the bank using bulldozers and scrapers, and sometimes is removed and stockpiled.

2.7.5 National Pollutant Discharge Elimination System (NPDES) Permit

Because of SCWA's jurisdiction over flood control channels within the Santa Rosa area, SCWA has entered into an interagency agreement with the City of Santa Rosa and the County of Sonoma for coverage under an NPDES permit for stormwater discharges. SCWA, the City of Santa Rosa, and the County of Sonoma own and operate stormwater conveyance systems that discharge stormwater into tributaries of Laguna de Santa Rosa, which is a tributary in the Russian River watershed. SCWA's flood control activities on Russian River tributaries in the Santa Rosa area affect and are affected by the NPDES permit and the interagency agreement with the City of Santa Rosa and the County of Sonoma.

2.7.6 Factors Affecting Species Environment

Channel maintenance activities in the Russian River watershed are conducted to reduce the risk of flooding of local property and bank erosion. Effects of these activities under baseline practices were evaluated in *Interim Report 5: Channel Maintenance* (ENTRIX, Inc. 2001a).

The most urbanized portion of the watershed is in Santa Rosa and the Cotati-Rohnert Park areas. These areas contain most of the constructed flood control channels. Sediment maintenance activities in constructed flood control channels reduce fish passage to spawning and rearing habitat and restrict downstream migration. However, natural waterways and constructed channels in the Rohnert Park area are generally low-gradient and run through a valley plain to the Laguna de Santa Rosa. Poor summer water quality from urbanized areas and low summer flows limit rearing habitat in these channels. Since rearing habitat is limited, there is only a moderate effect from sediment maintenance activities on salmonid populations.

Santa Rosa Creek drains to the Laguna de Santa Rosa, which in turn drains to Mark West Creek. Channel maintenance activities on constructed flood control channels and natural waterways in this part of the Mark West Creek watershed, including the Santa Rosa Creek watershed, have the potential to affect coho salmon and steelhead because this part of the watershed contains good rearing and spawning habitat for these species. Much attention has been given in recent years to restoration opportunities in this area. SCWA restoration actions within this watershed are outlined in Section 2.8.

SCWA channel maintenance activities under USACE obligations in Dry Creek are limited to maintenance of the 15 channel improvement sites. Potential spawning and rearing habitat for steelhead and Chinook salmon occurs in Dry Creek. Dry Creek does not contain primary coho salmon spawning and rearing habitat; and coho salmon generally use other tributaries for these life stages. Although removal of riparian vegetation at multiple sites may reduce cover and shading, the effects to listed fish species are limited. Vegetative growth along riprap sites is retained as long as it does not threaten slope stability or encourage erosion.

Bank stabilization activities in the Russian River potentially may have affected populations of listed fish species, because large amounts of river and stream channel habitat have been altered. This can happen, in particular, upstream of Asti in Mendocino County, where the most valuable spawning and rearing habitat occurs. Gravel bar grading and vegetation removal potentially affects listed fish species by reducing pool habitat formation, loss of high-flow refugia, as well as reducing shade canopy and cover. Loss of riparian vegetation associated with bank stabilization activities in the mainstem Russian River may have a moderate effect when shade canopy and cover are reduced.

Gravel bar grading occurs in the Mirabel and Wohler area to increase infiltration to the aquifer. The two-mile reach above the inflatable dam at Mirabel has relatively few structural features that would create low areas outside of the main channel. Given the characteristics of the river, gravel bar grading is not likely to significantly change the geomorphology of the channel. Effects from gravel bar grading operations are restricted to immediate, short-term effects, including a low risk of entrapment of migrating juveniles and short-term turbidity spikes as the Mirabel Bar is isolated or reconnected to the river. Therefore, the overall risk for injury and habitat degradation is low. The gravel bar grading activity in the upstream sites normally occurs after the coho salmon and Chinook salmon outmigration periods, although in some years it may occur during the later portion of the outmigration. There is a greater risk to steelhead juveniles, which are more likely to be present during gravel bar grading work. However, implementation of BMPs evaluated during the five-year monitoring study reduces the risk. Gravel bar grading at Mirabel normally occurs in late summer, and does not normally coincide with outmigration of salmonids. Fish rescues are conducted, and no salmonids were found in fish rescues in 1999.

2.8 RESTORATION AND CONSERVATION ACTIONS

SCWA has implemented many projects over the last several years that are designed to contribute to the conservation of natural resources in the Russian River watershed, particularly species listed under ESA. This includes projects that SCWA has either funded or implemented with staff time and materials, or with a combination of SCWA funding and other resources. These efforts include the general categories of watershed management, riparian and aquatic habitat protection, restoration, and enhancement. Actions that have been implemented before the MOU was signed (December 31, 1997) are part of the baseline.

2.8.1 WATERSHED MANAGEMENT

SCWA has historically been involved with watershed management activities in the Russian River watershed. Recently, SCWA has taken a more proactive role with regard to restoration and enhancement projects, and stewardship of the watershed. Several specific projects related to SCWA's contributions to watershed management in the Russian River basin are described below.

In March 1995 and October 1996, SCWA conducted two public workshops before its Board of Directors on watershed management activities, and specifically, SCWA's role in those activities. In August 1996, SCWA published the report, *The Russian River: An Assessment of Its Condition and Governmental Oversight*. In January 1997, SCWA began publishing the *Russian River Bulletin*, an interagency publication circulated among government agencies and other interested parties to describe new programs, legislation affecting or involving the Russian River, and the status of ongoing projects. In addition, SCWA has created a library, available to the public and other agencies, containing reports, documents, and other information pertinent to the Russian River watershed.

2.8.1.1 Russian River Basin Plan Review

SCWA is providing funding for the RWQCB to conduct a review of their Russian River Basin Plan (Basin Plan) to determine whether the requirements of the Basin Plan are sufficient to protect fish species in the Russian River. This information will assist ongoing efforts in the Russian River watershed for watershed management and protection of listed fish species. It will not only provide more information on the requirements of these species but also provide an assessment of the adequacy of existing regulatory requirements in protecting these species. The review may lead to changes in regulatory standards.

2.8.2 Riparian and Aquatic Habitat Protection, Restoration, and Enhancement

2.8.2.1 Fisheries Enhancement Program Project Descriptions

SCWA began implementation of the Fisheries Enhancement Plan (FEP) in 1996. SCWA’s Board of Directors has directed SCWA to develop the FEP for the tributaries of the Russian River watershed. Since 1996, SCWA has issued an annual Request for Proposals (RFP) for fisheries enhancement work within the Russian River watershed. Projects funded to date have included both on-the-ground restoration and research efforts.

Since 1996, SCWA has granted funds to various entities each year to provide habitat restoration and research on listed fish species in the Russian River watershed. For example, SCWA has provided funding to nonprofit groups, private landowners, and public agencies through the FEP program. In addition, SCWA has contributed staff time and materials to many of these projects.

In addition to the FEP projects, SCWA provided staff and materials for a training session on instream habitat enhancement structure construction in 1996. The training was offered to individuals in the community interested in working on habitat improvement projects, and created a pool of trained individuals to work with SCWA and CDFG on future habitat improvement projects.

1. Stream Habitat Surveys

   Stream habitat surveys have been conducted in cooperation with CDFG each year of the FEP since 1996, and are intended to assess the habitat conditions of streams that are potentially viable for salmonid production. The surveys are used to identify streams that are in need of enhancement or restoration. Surveys are conducted according to the CDFG Habitat Restoration Manual. All data gathered is entered into CDFG's computer program to prioritize stream restoration projects. SCWA has allocated staff and materials for this project.

2. Temperature Data Collection

   Water temperature monitoring has been conducted each year of the FEP since 1996 in collaboration with CDFG and Mendocino County Water Agency. These data will be used to identify streams that provide suitable summer thermal conditions for salmonid juvenile rearing. Data loggers (i.e., equipment to monitor and record water quality measurements at specific intervals) are removed annually from each stream during the fall and deployed again the following spring. Temperature data has been collected in the following watersheds: Mark West, Maacama, Austin, East Austin, Santa Rosa, Dutch Bill, Hulbert, Dry, Brush, Matanzas, and Big Sulphur creeks, as well as in the mainstem. SCWA has allocated staff and equipment for this project. The Mendocino County Water Agency compiles all temperature data into a single database.

3. Water Quality Sampling

This project includes collecting and identifying invertebrates from several streams in the Russian River watershed and analyzing the samples as indicators of water quality. Reference streams identified by CDFG have been sampled for a minimum of two years to establish a baseline reference condition. Other streams sampled are compared to those reference streams to determine relative water quality status. This project has been implemented each year since 1996. SCWA contributes staff and materials for the project. Additionally, SCWA provided funding for analysis of samples.

4. Instream Habitat Improvements

SCWA has funded and/or implemented projects every year since 1996 to improve habitat in stream channels. Streams were identified as candidates for instream habitat improvements, including Green Valley, Freezeout, Dutch Bill, and Austin creeks. Instream habitat structures that have been placed consisted of large woody debris, such as rootwads, that provide salmonids protective cover from predators and that promote development of pools. Fencing has also been installed. SCWA provided matching funds and staff support for these projects.

5. Riparian Restoration

SCWA has funded and/or implemented projects on Little Briggs, Green Valley, Austin, Copeland, and Freezeout creeks to exclude livestock from the riparian zone adjacent to the stream, and to replant degraded areas with native vegetation. These projects were intended to allow riparian vegetation to re-establish, stabilize streambanks, and decrease animal waste entering the stream. On Green Valley Creek, SCWA has also worked with Trout Unlimited and the landowners to provide temporary water supplies to restored riparian areas to increase the survival of newly planted trees. On Porter and Matanzas creeks, SCWA has implemented projects to enhance riparian habitat and stabilize streambanks. These projects consisted of placement of bioengineered erosion structures, such as willow mattresses and baffles, planting of native riparian trees in upslope areas, and educating landowners on ways to prevent erosion and the value of riparian vegetation along streambanks on their property. SCWA has provided funding, staff, and materials for these projects.

6. Green Valley Creek Restoration

Two restoration projects were implemented to improve habitat conditions for coho salmon and steelhead in Green Valley Creek. Both projects are designed to reduce streambank erosion. Green Valley Creek is one of the few tributaries in the Russian River watershed that still supports a self-sustaining, although diminished, population of threatened coho salmon. The Green Valley Creek watershed is held entirely in private ownership and efforts aimed at improving habitat conditions for species recovery require the voluntary participation of landowners. Trout Unlimited and CDFG constructed two streambank stabilization projects in 1996. Both projects were not performing as intended. One failed in 1998 and the other was in danger of failing. The sites delivered substantial amounts of fine sediment to the stream. Dragonfly Stream Enhancement, in conjunction with two private landowners, repaired both projects and arrested accelerated erosion at both sites. The site improvements include sloping and armoring of an eroding bank, planting of native vegetation to stabilize the sites, and removal of non-native vegetation. SCWA provided funding for the project.

Table 2-23 summarizes information about actions that are part of the baseline and, where known, indicates the listed fish species the action is likely to affect. Steelhead are the most abundant species in many of these areas, but as coho salmon or Chinook salmon populations are recovered, utilization of these streams by these species is likely to increase. All projects listed are likely to improve habitat for spawning, rearing, and migration of listed salmonids.

Table 2-23 Summary of Restoration and Conservation Actions

Creek	Type of Project	Size of Project	Species Affected[1]
Baseline Projects[2]			
Instream Habitat Improvements			
Green Valley	Contiguous structures and fencing	~ 1 mile	Co, St
Freezeout	3 non-contiguous structures		Co, St
Riparian Restoration			
Green Valley (streambank stabilization)	Erosion control	2 small projects	Co, St
Green Valley (livestock exclusion)	Fencing	> 1 mile	Co, St
Freezeout	Fencing	3,000 ft	St
Little Briggs	Fencing	> 1 mile	St
Porter	Willow walls & mattresses	~300 ft	St

[1]Co = Coho salmon, St = Steelhead, Ch = Chinook salmon

The size of the project is the actual length of stream affected.

[2]Actions completed prior to December 31, 1997.

2.9 FISH PRODUCTION FACILITIES AND OPERATIONS

DCFH and CVFF are fish production facilities located in the Russian River basin. The DCFH (also referred to as the Warm Springs Fish Hatchery) is located on Dry Creek at the base of WSD. The CVFF is a satellite facility for the steelhead program at DCFH and is located on the East Fork Russian River at the base of CVD. The facilities are owned by USACE and operated by CDFG under a cooperative agreement with USACE. Like all anadromous fish hatcheries in California, the Russian River facilities were developed to mitigate for the loss of spawning and rearing habitat for anadromous salmonids resulting from the construction of dams (CDFG and NMFS 2001).

Fish production goals for DCFH were established in 1974 to compensate for the estimated loss of coho salmon and steelhead production in Dry Creek upstream of WSD. Additional fish production was included in the hatchery program goals to enhance harvest opportunities for coho and Chinook salmon in the Russian River (USFWS 1978). Fish production goals for CVFF were established in 1984 to compensate for the estimated loss of steelhead production in the East Fork Russian River upstream of CVD (USACE 1986a). The DCFH and CVFF facilities went into service in 1980 and 1992, respectively.

This section outlines the fish production facilities and their operations as they have been operated under the baseline condition as mitigation hatcheries. A detailed description of the baseline program is presented in *Interim Report 2: Fish Operations Facility* (FishPro and ENTRIX, Inc. 2000).

2.9.1 BACKGROUND OF FISH FACILITY DEVELOPMENT

To compensate for loss of spawning and rearing habitat upstream of WSD and CVD, various laws were enacted that ultimately led to development of the DCFH and CVFF. Construction of DCFH was authorized by the Flood Control Act of 1962. DCFH went into service on October 1, 1980, operated by CDFG under an agreement with USACE.

Section 203 of the Flood Control Act of 1962 was later modified by Section 95 of Public Law 93-251, the Water Resources Development Act of 1974, requiring a program to compensate for fish losses on the Russian River attributed to the operation of CVD. In January 1983, the South Pacific Division USACE directed the Sacramento District USACE to assume responsibility for the CVD Fish Mitigation Project, and to determine what work would be required to comply with Public Law 93-251. The determination resulted in the development of CVFF, along with an expansion of the DCFH. Both the CVFF and the DCFH expansion became operational in 1992. Like DCFH, CVFF is operated by CDFG under an agreement with USACE. In October 1996, the South Pacific Division USACE transferred control of Lake Sonoma and Lake Mendocino, including both fish facilities, to the San Francisco District USACE.

No quantitative estimates were conducted to determine the actual carrying-capacity of affected areas prior to the time the facilities began operations. Instead, mitigation goals were developed from estimates of run-size within the sub-basins and additional estimates based upon the proportion of coho salmon and steelhead spawning habitat upstream of the dam locations. However, insufficient data existed to support these estimates. Population estimates for coho salmon and steelhead vary widely among studies because they are based primarily on anecdotal information or on assumptions of habitat quality.

It has been estimated that prior to the construction of WSD, the Dry Creek sub-basin supported a run of approximately 8,000 steelhead and 300 coho salmon (CDFG 1970). Approximately 75 percent of the steelhead (6,000) and 33 percent of the coho salmon (100) were believed to spawn in sections of Dry Creek and its tributaries that are now upstream of the dam (CDFG 1970). Salmon and steelhead continue to use Dry Creek downstream of the dam for spawning and rearing.

The size of the adult steelhead run in the Russian River has never been quantified. In the process of determining mitigation goals for the Lake Mendocino project, it was estimated that the sub-basin upstream from CVD supported a run of 4,000 steelhead prior to construction of the dam.

2.9.2 Program Goals

DCFH and CVFF facilities were developed with the goal of developing and maintaining an escapement of 1,100 adult coho salmon, 6,000 adult steelhead, and 1,750 adult Chinook salmon in the Dry Creek drainage and 4,000 adult steelhead in the upper Russian River drainage. To achieve these escapement goals, production goals were also established for egg harvest and fish-release numbers at the DCFH. Similarly, goals for egg-harvest numbers and pounds of yearling releases were established for the CVFF. Based on a desired CVFF release size of five fish per pound, the 40,000 pounds of steelhead can be equated to 200,000 steelhead individuals. Existing production and adult escapement goals for DCFH and CVFF are summarized in Table 2-24.

Table 2-24 Existing Hatchery Program Goals for DCFH and CVFF

Location/Species	Mitigation/ Enhancement	Egg Harvest	Juvenile Releases	Adult Escapement
Don Clausen Fish Hatchery				
Steelhead	Mitigation	600,000	300,000 yearling	6,000
Coho Salmon	Mitigation	20,000	10,000 yearling	100
Coho Salmon	Enhancement	200,000	100,000 yearling	1,000
Chinook Salmon	Enhancement	1,400,000	1,000,000 smolts	1,750
Coyote Valley Fish Facility				
Steelhead	Mitigation	320,000	200,000 yearling	4,000

At the time the existing program goals were developed, the following definitions, and management guidelines were assumed:

Steelhead:

Yearling release size: 4 to 5 fish per pound or larger

Fecundity: 5,000 eggs per female

Survival from unfertilized egg to stocked yearling: 50 percent

Survival from stocked yearling to adult return at hatchery: 2 percent

Coho Salmon:

Yearling release size: 10 fish per pound or larger

Fecundity: 2,000 eggs per female

Survival from unfertilized egg to stocked yearling: 50 percent

Survival from stocked yearling to adult return at hatchery: 1 percent

Chinook Salmon:

Smolt: 50 fish per pound or larger

Yearling release size: 10 fish per pound or larger

Fecundity: 4,000 eggs per female

Survival from unfertilized egg to stocked smolt: 75 percent

Survival from stocked smolt to adult return at hatchery: 0.175 percent

The existing program goals for DCFH and CVFF assumed a survival rate from release to adult return at the hatchery. Actual survival following release is affected by many factors beyond the control of hatchery operations. While hatchery practices may influence marine survival of salmon, marine survival is also related to ocean-wide factors in the marine environment in the North Pacific, such as climate changes (Beamish and Bouillon 1992). In addition, commercial and sport harvest can have a significant effect on hatchery returns. The stated management goals for survival from yearling release to hatchery return are 2 percent for steelhead and 1 percent for coho salmon. In general, these values appear to be significantly higher than the current survival rates for any west coast stocks of steelhead or coho salmon, whether of natural or hatchery origin (B. Coey, CDFG, pers. comm. March 29, 2000). If actual conditions are not able to support the assumed survival rate, then it is unlikely that the desired adult escapement will ever be achieved if release goals are followed.

No estimates of current carrying-capacity have been developed to confirm that the remaining spawning and rearing habitat is capable of supporting the mitigation and enhancement production goals. Also, there are no programs to assess the potential for competition among naturally and hatchery-spawned components of the same species, or between any of the three salmonid species or other fauna present in the Russian River during the same time periods.

2.9.3 BROODSTOCK ORIGIN AND IDENTITY

Prior to 1999, broodstock for coho salmon, steelhead, and Chinook salmon production programs were derived, in part, by adult capture within the Russian River, and via stock transfers from a variety of sources (R. Gunter, CDFG, pers. comm., 1999) (Table 2-25). The following is a summary of the origin of hatchery salmonid stocks in the Russian River basin.

2.9.3.1 Steelhead

Since 1982, the source of broodstock for Russian River hatchery-reared steelhead has been limited to progeny of fish returning to DCFH and CVFF (R. Gunter, CDFG, pers. comm. 1999). Broodstock for the DCFH program are collected from fish returning to the DCFH ladder and trap, while those for the CVFF program are collected from fish returning to the CVFF ladder and trap. During the start-up of DCFH in 1980 and 1981, broodstock were derived, in part, by adult capture within the Russian River, and via stock transfers from a variety of sources (R. Gunter, CDFG, pers. comm. 1999) (Table 2-25).

Table 2-25 Broodstock Source, Stocking Year, and Number of Steelhead Released in the Russian River

Broodstock Source	Years Outplanted	Total Outplants
Russian River	1959, 81-98	18,167,885
Eel River	1914-19, 21-23, 58-59, 72, 96-98	5,009,156
Mad River	1975-76, 78-79, 81	324,101
Prairie Creek	1927	249,000
San Lorenzo Creek	1973	83,350
Scott Creek	1911	433,458
Unknown		8,934,122
Washougal	1980-81	270,360
Total		**33,471,432**
% Russian River Origin[1]		**54%**

Data compiled from Steiner Environmental Consulting (1996) and CDFG (1996b, 1997, and 1998b).
[1]The percentage applies to number planted. Data are not available on survival rates.

Out-of-basin steelhead stocks were first planted into the Russian River basin beginning in the 1890s, and continued through 1982 (CDFG 1998). Based on a detailed report by Steiner (1996) describing the origin of hatchery stocks in the Russian River basin, sources of broodstock for these plants, along with the last known year of planting, included the Eel River (1998), Prairie Creek (1927), Mad River/Eel River hybrids (1974), San Lorenzo Creek (1973), Scott Creek (1911), and Washougal River (Washington) (1981) (Table 2-25).

Russian River adults provided the source of broodstock for about 54 percent of steelhead releases between the 1890s and 1998. There is no known information regarding the survival of fish from outplants prior to the current DCFH/CVFF program. Even so, given the magnitude and duration of historical stock transfers, naturally spawning steelhead within the Russian River probably represent a genetic conglomerate of many stocks, although data are unavailable to quantify the degree of introgression. Similarly, the adults used as broodstock are probably descendants of many stocks. While the history of stock transfers in the Russian River suggests that genetic integrity has been compromised, the current policy of exclusively collecting broodstock from returns to the Russian River should allow selection and genetic drift to give rise to Russian River-specific stocks.

Currently, steelhead broodstock are collected systematically across the entire adult return period with weekly capture goals formulated by a 9-to-11-year mean for each species.[9] In an attempt to increase genetic diversity, more individuals are spawned than are necessary to achieve production goals. Surplus eggs are then randomly destroyed to avoid surplus production.

Over recent years, the number of female steelhead used as broodstock has varied considerably (Table 2-26). Unfortunately, the number of males used as broodstock is not recorded in hatchery records, and is difficult to determine given changes in spawning protocols. In practice, returning hatchery-reared individuals are the primary source of broodstock, although naturally spawned adults have been retained whenever possible.

Table 2-26 Number of Steelhead Females Spawned at DCFH in 1995 to 1998

Brood Year	Number of Females Spawned
1995	405
1996	407
1997	401
1998	157

Releases

DCFH

Data regarding number, pounds, and average size at release are presented for steelhead, based on DCFH production records from 1981 to 1999 (Table 2-27). In general, a steelhead production goal of 300,000 fish has been achieved every year since 1992, which reflects the improvements in rearing facilities and water supply that were completed that year. Releases of steelhead show significant variation. Survival from unfertilized egg to stocked yearling routinely surpasses the management goal of 50 percent.

Grading operations are conducted on steelhead to identify fish larger than four fish per pound and then these fish are released. Until 1999, any remaining undersized fish were released by the end of April. Until July 1999, if there were surplus eggs, fry and fingerling were stocked in the drainage.

[9] The 9-to-11-year mean is used to predict the shape of the distribution of adult returns. The absolute number of years used to create this distribution is arbitrary.

CVFF

Data regarding number, pounds, and average size of steelhead releases from CVFF are presented in Table 2-27, based on CVFF production records from 1993 to 1999. Each December, when grading of yearling steelhead commences at DCFH, all fish that are progeny of adults collected at CVFF and larger than 5 fish per pound are transported to CVFF to acclimate. Volitional release is allowed to occur, but any fish remaining after a 30-day period are forced from the ponds. Similar to DCFH, previous practices that allowed stocking of excess eggs and undersize fish continued until July 1999. In general, the steelhead production goal has been achieved every year except the year of initial start-up. Similar to DCFH, stocking of excess eggs and undersized fish occurred until 1999.

Table 2-27 DCFH and CVFF Steelhead Release History

Year[1]	Fingerling			Yearling		
	Number	Pounds	Avg FPP[2]	Number	Pounds	Avg FPP[2]
Don Clausen Fish Hatchery						
1981-1982	253,436	682	372	53,380	10,975	5
1982-1983	226,710	762	298	102,662	18,225	6
1983-1984	459,970	2,119	217	124,146	22,730	5
1984-1985	608,680	647	941	155,305	42,360	4
1985-1986	539,157	4,108	131	212,365	27,500	8
1986-1987	1,316,469	4,842	272	237,753	68,405	3
1987-1988	720,579	930	775	224,963	60,560	4
1988-1989	578,780	712	813	233,979	58,950	4
1989-1990	347,347	551	630	212,769	56,175	4
1990-1991	121,326	1,893	64	243,881	64,320	4
1991-1992	1,188,663	3,406	349	335,181	86,775	4
1992-1993	1,249,521	3,571	350	321,890	75,975	4
1993-1994	627,730	1,532	410	355,164	86,809	4
1994-1995	397,455	2,676	149	309,458	78,524	4
1995-1996	134,000	67	2,000	316,758	88,700	4
1996-1997	279,088	381	733	312,388	86,376	4
1997-1998	119,681	522	229	348,734	99,295	4
1998-1999[3]	46,062	1,153	40	341,339	88,425	4
Coyote Valley Fish Facility						
1992-1993	0	0	0	165,469	26,839	6
1993-1994	227,313	365	623	213,872	46,472	5
1994-1995	107,667	238	452	235,416	44,659	5
1995-1996	76,670	6,950	11	224,702	44,647	5
1996-1997	122,188	594	206	206,333	40,400	5
1997-1998	110,981	369	301	242,438	48,528	5
1998-1999[3]	164,770	1,086	152	231,320	45,448	5

[1]Year extends from July 1 of the first year through June 30 of the second year.

[2]Avg FPP = average size (fish per pound) at release.

[3]Releases made after the 1997-1998 year are not part of the baseline.

Adult Returns

Adult returns to DCFH and CVFF are presented in Table 2-28. Since operations began, DCFH has achieved the steelhead mitigation goal of 6,000 adult escapement only one time. At the CVFF, the mitigation goal of 4,000 returning fish has yet to be achieved. Peak returns occurred in 1997, when 3,727 adult steelhead were counted at CVFF. The survival estimate used to establish juvenile release goals is likely a contributing factor in the poor success of meeting adult escapement goals.

Table 2-28 History of Steelhead Trapped at DCFH and CVFF

Year[1]	DCFH				CVFF			
	Male	Female	1/2-Pound	Total	Male	Female	1/2-Pound	Total
1980-1981	148	185	0	333				
1981-1982	124	235	0	359				
1982-1983	322	242	0	564				
1983-1984	1,039	923	0	1,962				
1984-1985	369	468	0	837				
1985-1986	812	484	4	1,300				
1986-1987	519	696	36	1,251				
1987-1988	660	375	10	1,045				
1988-1989	453	421	17	891				
1989-1990	428	260	15	703				
1990-1991	239	181	3	423				
1991-1992	750	834	7	1,591				
1992-1993	1,378	1,289	2	2,669	182	120	8	310
1993-1994	856	895	9	1,760	229	198	13	440
1994-1995	3,561	4,525	14	8,100	1,147	1,054	9	2,210
1995-1996	2,135	1,958	12	4,105	1,129	980	6	2,115
1996-1997	1,729	1,910	9	3,648	1,793	1,934	8	3,735
1997-1998	656	687	1	1,344	619	932	8	1,559
1998-1999[2]	1,219	1,012	5	2,236	793	798	5	1,596

[1]Year extends from July 1 of the first year through June 30 of the second year.

[2]Activities after 1997-1998 are not part of the baseline.

Harvest Management

Current fishing regulations allow the take of hatchery-reared steelhead. (Steelhead releases from DCFH and CVFF are marked with clipped adipose fins.) Harvest of naturally spawned steelhead is prohibited. While this strategy minimizes direct fishing mortality, indirect effects such as hooking mortality and harassment may still affect naturally spawned adults. There are no current estimates of harvest levels of steelhead within the Russian River.

2.9.3.2 Coho Salmon

The DCFH produced and released an average of about 70,000 age 1+ coho salmon each year (1980 to 1998). There has been no hatchery production of coho salmon since 1998. DCFH facilities were developed with the goal of developing and maintaining an escapement of 1,100 adult coho salmon in Dry Creek.

Broodstock for the DCFH program were collected from fish returning to the DCFH ladder and trap. Before 1999, broodstock for these programs were derived in part by adult capture within the Russian River, and via stock transfers from a variety of sources (R. Gunter, CDFG, pers. comm., 1999) (Table 2-29).

Table 2-29 Broodstock Source, Stocking Year, and Number of Coho Salmon Released in the Russian River

Broodstock Source	Years Outplanted	Total Outplants
Russian River	1983, 85-98	752,372
Alsea River	1972	58,794
Eel River	1987, 90	25,112
Klamath River	1975, 81-83, 86-88, 96-98	451,370
Noyo River	1970, 72-74, 82-84, 86-91	613,056
Soos Creek	1978	8,420
Unknown		403,340
Total		**2,312,464**
% Russian River Origin[1]		**33%**

Data compiled from Steiner Environmental Consulting (1996) and CDFG (1996b, 1997, and 1998b).
[1]The percentage applies to numbers planted. Data are not available on survival rates.

Out-of-basin coho salmon stocks were first planted into the Russian River basin beginning in the 1930s, and continued through at least 1998 (CDFG 1998). Out-of-basin broodstock sources and the last year of outplanting that occurred before the DCFH program include the Alsea River, OR (1972) and Soos Creek, WA (1978). There is no information regarding the survival of fish from these outplants. Since the DCFH coho salmon program started, broodstock sources have included fish from the Noyo, Klamath, and Eel rivers in addition to Russian River. Due to the low number of returning adults, all coho salmon that entered the DCFH in recent years were used as broodstock.

A summary of Russian River outplants and their source of broodstock through 1998 is presented in Table 2-29, based on Steiner (1996) and annual reports of DCFH operations (CDFG 1996b, 1997, 1998). Based on this information, Russian River adults provided the source of broodstock for about 33 percent of coho salmon releases. It should be emphasized that many of these fish plants occurred before the current DCFH program was in place. Further, there is no known information regarding the survival of fish from outplants prior to the current DCFH program. Even so, given the magnitude and duration of historical stock transfers, it is likely that naturally spawning coho salmon within the

Russian River represent a genetic conglomerate of many stocks, although data are unavailable to quantify the degree of introgression. Similarly, the adults used as broodstock are themselves likely to be descendants of many stocks. While the history of stock transfers in the Russian River suggests that genetic integrity has been compromised, the recent policy of collecting broodstock from returns to the Russian River should allow selection and genetic drift to give rise to Russian River-specific stocks.

Over the last four years of the coho salmon program, the numbers of female coho salmon used as broodstock varied considerably (Table 2-30). Numbers of fish returning to the DCFH were low. Further, in 1998, there was a change in policy that eliminated use of out-of-basin fish as broodstock. Unfortunately, the number of males used as broodstock is not recorded in hatchery records, and is difficult to determine given changes in spawning protocols. In practice, returning hatchery-reared individuals were the primary source of broodstock, although naturally spawned adults were retained whenever possible.

Table 2-30 Number of Coho Salmon Females Spawned at DCFH in 1995 to 1998

Brood Year	Number of Females Spawned
1995	349
1996	32
1997	147
1998	0

Releases

Data regarding number, pounds, and average size at release are presented for coho salmon (Table 2-31), based on DCFH production records from 1981 to 1999. Coho salmon releases show significant variation. Coho salmon releases surpassed the production goal of 110,000 from 1987 to 1992, but poor returns in recent years did not allow adequate egg harvest to meet production goals. Comparison of relevant data on adult returns and egg harvest indicates that coho salmon release numbers are directly related to availability of broodstock, and low release numbers should not be construed as a reflection of hatchery operations. Survival from unfertilized egg to stocked yearling routinely surpasses the management goal of 50 percent.

Release Protocols

While coho salmon were not volitionally released, they were sorted by size, and larger individuals were released while smaller individuals were retained until reaching a larger size. Larger individuals are assumed to emigrate more quickly than smaller individuals, thereby decreasing the risk of freshwater predation and competition. Furthermore, releases were not made in the smaller tributaries where primary spawning and rearing occurs, with the exception of Dry Creek. DCFH releases use a transport truck to haul the fish from the hatchery to their final release location in Dry Creek.

Due to release locations, all coho salmon were acclimated to a certain degree within the Russian River system, suggesting that straying to out-of-basin rivers was unlikely to be a great concern. The DCFH coho salmon were not directly acclimated per se. However, rearing is accomplished using Lake Sonoma water, and release occurs in Dry Creek about three miles downstream from the hatchery. In each case, coho salmon would be expected to return to capture facilities rather than non-natal tributaries.

Table 2-31 Don Clausen Fish Hatchery Coho Salmon Release History

Year[1]	Fingerling			Yearling		
	Number	Pounds	Avg FPP[2]	Number	Pounds	Avg FPP[2]
1981-1982	66,400	1,050	63	30,820	4,600	7
1982-1983	82,987	1,190	70	32,305	3,310	10
1983-1984	3,800	126	30	30,310	4,330	7
1984-1985	67,750	1,010	67	0	0	0
1985-1986	42,525	525	81	86,425	7,325	12
1986-1987	40,809	704	58	123,570	16,250	8
1987-1988	82,211	1,350	61	104,324	17,875	6
1988-1989	0	0	0	100,680	13,083	8
1989-1990	0	0	0	128,755	14,200	9
1990-1991	0	0	0	110,690	12,625	9
1991-1992	0	0	0	137,400	15,075	9
1992-1993	0	0	0	85,859	10,605	8
1993-1994	0	0	0	55,528	9,700	6
1994-1995	0	0	0	27,186	2,699	10
1995-1996	0	0	0	96,180	27,570	3
1996-1997	0	0	0	23,380	8,500	3
1997-1998	0	0	0	60,590	8,795	7
1998-1999[3]	0	0	0	0	0	0

[1]Year extends from July 1 of the first year through June 30 of the second year.
[2]Avg FPP = average size (fish per pound) at release.
[3]Releases made after the 1997-1998 year are not part of the baseline.

Adult Returns

Adult returns to DCFH are presented in Table 2-32. The coho salmon mitigation goal of 100 adult fish has been met 11 out of 19 years, but the enhancement goal calling for an additional 1,000 adult returns has never been achieved. As noted previously, survival estimates used in establishing juvenile release goals is probably a contributing factor in the poor success of meeting adult escapement goals.

Table 2-32 History of Coho Salmon Trapped at Don Clausen Fish Hatchery

Year[1]	Male	Female	Grilse	Total
1980-1981	0	0	0	0
1981-1982	2	2	0	4
1982-1983	515	277	194	986
1983-1984	0	1	8	9
1984-1985	32	44	0	76
1985-1986	0	0	0	0
1986-1987	139	5	328	472
1987-1988	164	155	257	576
1988-1989	219	139	176	534
1989-1990	35	35	70	140
1990-1991	100	87	90	277
1991-1992	53	20	89	162
1992-1993	250	113	215	578
1993-1994	110	62	277	449
1994-1995	310	392	63	765
1995-1996	13	13	36	62
1996-1997	68	68	12	148
1997-1998	1	3	0	4
1998-1999	2	1	5	8

[1]Year extends from July 1 of the first year through June 30 of the second year.

Harvest Management

Harvest of coho salmon is prohibited within the Russian River basin. However, there is a fishery within the basin for hatchery-reared steelhead. While this strategy minimizes direct fishing mortality of coho salmon, indirect effects such as hooking mortality and harassment may still occur. There are no current estimates for incidental harvest levels of coho salmon within the Russian River.

2.9.3.3 Chinook Salmon

The original DCFH production goals called for an escapement of 1,750 adult Chinook salmon to the Russian River system.

Hatchery-reared Chinook salmon were first planted into the Russian River beginning in the 1880s (CDFG 1998) and most recently planted in 1999. Between 1881 and 1995, over 8 million Chinook salmon were planted, all hatchery-reared except 2,382 fish rescued from the Eel River in 1939 (CDFG 1939, cited in Steiner 1996). From 1980 to 1989, only 15 percent of the Chinook salmon plants from the DCFH were progeny of adult returns, but since 1990, all Chinook salmon plants were progeny of local returns (Steiner 1996).

Out-of-basin stocks were planted in the Russian River beginning in the 1880s and continued through at least 1998 (CDFG 1998). Prior to 1980, all Chinook salmon planted were progeny of out-of-basin stocks. Stocks that were planted prior to the DCFH program include Sacramento River (1950s-1960s), Mad River (1953), and Klamath River (1955-56). The failure of planting efforts from 1949 to 1962 to establish a viable population has been attributed to the use of fall-run Chinook salmon. Spawners from these stocks that returned to the river in July encountered unsuitably high water temperatures and seasonal summer dams inhibited upstream migration in the summer (Steiner 1996). After 1963, winter-run stocks were used. There is no information regarding the survival of fish from these outplants. Since the DCFH program began, broodstock sources have included Eel River, Wisconsin Strain (Green River, Washington), and Silver King Creek (location unknown), in addition to Russian River.

A summary of Russian River outplants and their source of broodstock through 1998 is presented in Table 2-33, based on Steiner (1996) and annual reports of DCFH operations (CDFG 1996, 1997, 1998). Based on this information, Russian River adults provided the source of broodstock for about 6 percent of Chinook salmon releases. It should be emphasized that many of these fish plants occurred before the current DCFH program was in place. Further, there are no data regarding the survival of fish from outplants before the current DCFH program. Given the magnitude and duration of historical stock transfers, naturally spawning Chinook salmon within the river may represent a genetic conglomerate of multiple stocks. Similarly, the adults used as broodstock may be descendants of multiple stocks. Although the history of stock transfers in the Russian River suggests that genetic integrity may have been compromised, the recent policy of collecting broodstock from returns should allow selection and genetic drift to give rise to Russian River-specific stocks. A recent study (Hedgecock et al. 2003) indicates Chinook salmon in the Russian River are not closely related to Central Valley or Eel River populations, and concludes they belong to a diverse set of coastal populations.

Table 2-33 Broodstock Source, Stocking Year, and Number of Chinook Salmon Released in the Russian River[1]

Broodstock Source	Years Outplanted	Total Outplants
Russian River	1985, 87-90, 92-98	542,478
Eel River	1982,84,86-89,96-98	218,257
Klamath River	1955-56	1,000,000
Mad River	1953	9,250
Sacramento River	1956, 59-60, 62-64	3,283,295
Silver King Creek	1982-83	70,000
Unknown		2,265,292
Wisconson[2]	1982-86	1,337,624
Total		**8,726,196**
% Russian River Origin[3]		**6%**

[1]Data compiled from Steiner Environmental Consulting (1996) and CDFG (1996, 1997, and 1998).
[2]Originated from Green River, WA.
[3]The percentage applies to numbers planted. Data are not available on survival rates.

Over the last four years of the DCFH Chinook salmon program, the numbers of female Chinook salmon used as broodstock have been low and have varied considerably (Table 2-34). Unfortunately, the number of males used as broodstock is not recorded in hatchery records, and is difficult to determine given changes in spawning protocols. In practice, returning hatchery-reared individuals were the primary source of broodstock, although naturally spawned adults were used whenever possible.

Table 2-34 Number of Chinook Salmon Females Spawned at DCFH in 1995 to 1998

Brood Year	Number of Females Spawned
1995	11
1996	49
1997	24
1998	7

Releases

Data regarding number, pounds, and average size at release are presented for Chinook salmon (Table 2-35), based on DCFH production records from 1981 to 1999. Returns of Chinook salmon have never allowed adequate egg take to achieve the release goal of 1 million smolts. Comparison of relevant data on adult returns and egg harvest indicates that Chinook salmon release numbers were directly related to availability of broodstock, and low-release numbers should not be construed as a reflection of hatchery operations. Survival from unfertilized egg to stocked yearling routinely surpassed the management goal of 50 percent.

Release Protocols

The management plan for the hatchery calls for Chinook salmon to be reared to the smolt stage (about 50 fish per pound) and released during April or May. If numbers of Chinook salmon are low, the manager may choose to rear them to yearling size (10 fish per pound and larger), with releases completed by November 1. Based on an increase in survival seen when the Central Valley facility switched from smolt to yearling releases, all DCFH Chinook salmon releases between 1994 and 1999 occurred as yearling.

Hatchery-reared Chinook salmon released as yearling in the fall will migrate to the ocean at a larger size than their naturally spawned smolt counterparts. This suggests that direct predation may occur if hatchery releases overlap natural production on either a spatial or temporal basis. While Chinook salmon were not volitionally released, they were sorted by size, and larger individuals were released while smaller individuals were retained until reaching a larger size. Larger individuals may emigrate more quickly than smaller individuals, decreasing the risk of freshwater predation and competition.

Table 2-35 DCFH Chinook Salmon Release History

Year[1]	Fingerling			Yearling		
	Number	Pounds	Avg FPP[2]	Number	Pounds	Avg FPP[2]
1981-1982	102,360	2,160	47	0	0	0
1982-1983	68,750	2,083	33	20,900	3,074	7
1983-1984	66,120	1,740	38	0	0	0
1984-1985	211,510	4,697	45	0	0	0
1985-1986	884,520	18,595	48	0	0	0
1986-1987	92,765	1,835	51	34,592	3,225	11
1987-1988	54,150	1,275	42	0	0	0
1988-1989	237,450	6,800	35	0	0	0
1989-1990	13,770	270	51	36,037	3,837	9
1990-1991	0	0	0	0	0	0
1991-1992	113,525	2,525	45	0	0	0
1992-1993	8,877	269	33	0	0	0
1993-1994	0	0	0	50,300	4,800	10
1994-1995	0	0	0	0	0	0
1995-1996	0	0	0	25,923	13,000	2
1996-1997	0	0	0	31,990	10,000	3
1997-1998	0	0	0	7,800	750	10
1998-1999[3]	0	0	0	11,730	2,300	5

[1]Year extends from July 1 of the first year through June 30 of the second year.
[2]Avg FPP = average size (fish per pound) at release.
[3]Releases made after the 1997-1998 year are not part of the baseline.

Rearing of all DCFH Chinook salmon production used Lake Sonoma water, and releases occurred in Dry Creek about three miles downstream from the hatchery. Due to these rearing and release locations, all Chinook salmon were acclimated to a certain degree within the Russian River system, suggesting that straying to out-of-basin rivers is unlikely to be a great concern. Adult Chinook salmon would probably return to release streams rather than non-natal tributaries.

Adult Returns

Adult returns to the DCFH are presented in Table 2-36. Since operations began, DCFH has never achieved the Chinook salmon goal of 1,750 adult returns, with a maximum return of 304 fish. The survival estimates used in establishing juvenile release goals may be a contributing factor in the poor success of meeting adult escapement goals.

Table 2-36 History of Chinook Salmon Trapped at DCFH

Year[1]	Male	Female	Grilse	Total
1980-1981	0	0	0	0
1981-1982	0	0	0	0
1982-1983	1	0	0	1
1983-1984	2	1	1	4
1984-1985	7	1	0	8
1985-1986	65	0	0	65
1986-1987	50	25	36	111
1987-1988	176	4	124	304
1988-1989	151	61	21	233
1989-1990	8	6	3	17
1990-1991	67	0	32	99
1991-1992	77	46	2	125
1992-1993	15	22	3	40
1993-1994	8	0	13	21
1994-1995	59	9	17	85
1995-1996	18	12	3	33
1996-1997	25	11	7	43
1997-1998	16	14	19	49
1998-1999[2]	1	0	3	4

[1]Year extends from July 1 of the first year through June 30 of the second year.
[2]Activities after 1997-1998 are not part of the baseline.

Harvest Management

Fishing regulations would allow the take of hatchery-reared Chinook salmon (Chinook salmon releases are marked with clipped adipose fins), but the current lack of hatchery Chinook salmon production precludes the harvest of Chinook salmon within the Russian River basin. Harvest of naturally spawned Chinook salmon is prohibited. While this strategy minimizes direct fishing mortality of Chinook salmon, indirect effects such as hooking morality and harassment may still occur. There are no current estimates for incidental harvest levels of Chinook salmon within the Russian River.

Importation of Stocks

The DCFH participates in an egg-banking program for a unique run of late fall Chinook salmon from the Eel River. Eggs are brought to the DCFH for incubation. When they reach the eyed-egg life stage, half of these eggs are sent to Mad River Hatchery to continue incubation and rearing. The remaining eggs are kept at DCFH, reared to the juvenile stage, then returned to the Eel River where they are imprinted on Eel River water and released. The adult fish that are the source of eggs for this program are tested for viral pathogens and screened for *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (Dr. W. Cox, pers. comm., 1999).

Until 1999, DCFH also received eggs from a coho salmon stock in the Noyo River. Adult fish used as the source of these eggs were tested for viral pathogens (Dr. W. Cox, pers. comm., 1999). Upon arrival at the DCFH, the Noyo River eggs were disinfected with iodophore solution to remove surface pathogens that may have been present. Egg lots were incubated separately until completion of viral certification, after which time the egg lots could be combined. After reaching the eyed-egg life stage, the eggs were transferred to Mad River for hatching, rearing, and release (R. Gunter, pers. comm., 1999). Occasionally, some of the eggs from this source were kept at DCFH and reared for planting into the Russian River for enhancement purposes, but both this practice and the entire Noyo River incubation program have been discontinued (R. Gunter, pers. comm., 2000).

2.9.4 Factors Affecting Species Environment

Potential effects on listed coho salmon, steelhead, and Chinook salmon in the Russian River basin that may arise from the existing fish facility operations were evaluated in *Interim Report 2 Fish Facility Operations* (FishPro, Inc. and ENTRIX, Inc. 2000). Operating practices of the DCFH and CVFF facilities reflect a commitment to minimizing effects on listed populations. Procedures for waste treatment demonstrate continuous compliance with recommended discharge standards for water quality. The facilities have been able to effectively manage routine fish diseases, and recent changes in policy regarding importation of stocks have resulted in minimal likelihood of effects on listed stocks due to disease. Similarly, current operations relating to production goals and harvest indicate the most practicable approach to minimizing ecological effects such as competition, predation, and overexploitation.

In general, there is a low risk of adverse effects to listed fish populations. Given the mixed stock history of DCFH and CVFF, adult salmonids currently returning to the facility may be of mixed origin. Therefore, the risk of outbreeding depression is potentially higher than would be the case had broodstock always been collected locally. Over the last four years of the Chinook salmon program, the numbers of female Chinook salmon returning to the hatchery decreased considerably, reflecting the shift to local broodstock rather than out-of-basin sources. The number of Chinook salmon spawned during that time was well below the suggested minimum of 100 adult pairs, and therefore hatchery Chinook salmon may have incurred an unfavorable level of inbreeding. There is a low risk of artificial selection in the hatchery program because traditional rearing techniques are used and because the naturally-spawned individuals are not used as broodstock. Hatchery production of steelhead may contribute to competition with naturally spawned steelhead, and there is a low risk that hatchery fish may prey on listed naturally produced fish because they are released at a larger size. However, steelhead releases are not generally made in primary spawning or rearing habitat, and the volitional release strategies employed at CVFF minimize these risks even further.

2.10 SUMMARY OF FACTORS AFFECTING SPECIES ENVIRONMENT

This section summarizes factors that affect the species environment under current conditions and operations. Non-project effects will be more fully addressed in the Draft BA. These included factors related to operation of the PVP; barriers to migration, local land uses such as urban development, wastewater discharges, gravel mining, timber harvest, and agriculture, and; sediment/siltation.

Potential effects to salmonid populations from SCWA and USACE activities in the Russian River can be grouped into several subcategories:

- Operational Effects
    - flow recessions
    - entrainment and impingement
    - barriers to outmigration
- Effects Related to Water Management
    - summer flows
    - winter flows
- Channel Maintenance Activities
- Fish Production Facilities

Dam and water diversion facility operations may result in effects to juvenile salmonids including stranding, entrainment, and impingement, and barriers to outmigration.

The primary factor related to SCWA and USACE activities affecting salmonid populations in the Russian River system is the regulation of flow conditions. Flow (velocity and depth) is considered to be a key determinant in the quantity and quality of physical salmonid habitat in areas downstream of the dams. Flow also influences water quality parameters including temperature and DO, thereby affecting habitat quality. In the Russian River system, flows exert their effects primarily on the quantity and quality of rearing habitat available.

Fish production facility operations may also affect naturally reproducing populations of listed fish species through competition, predation, and effects to genetic integrity. Other influences on salmonid populations are related to the presence of predatory species in areas of warmer, slow-moving water.

2.10.1 OPERATIONAL EFFECTS

Operation of various USACE and SCWA facilities in the Russian River system have the potential to affect listed fish species. Potential effects related to operations at CVD and the Mirabel and Wohler diversion facilities are discussed below.

2.10.1.1 Flow Recessions

Coyote Valley Dam Inspection and Maintenance Activities

Releases from the dam are decreased (ramped down) or cease during inspection and maintenance activities or during the transition to or from hydroelectric operations. Two issues arose in the evaluation of potential effects on juvenile salmonids, flow reduction during these activities, and timing of inspections. When flows are decreased (ramped down) or cease, downstream habitat is subjected to flow recessions and dewatering. Stranding of juvenile salmonids has been documented. When inspections occur in the late winter/spring, fry (small fish are more susceptible) may be present. Under baseline conditions, the criterion for ramping-down releases from the dam when flows are less than 250 cfs is 50 cfs/hr.

Monitoring during inspection and maintenance activities provided information about risk for stranding. At CVD, rescue of juvenile steelhead has been necessary on the East Fork and further downstream on the mainstem Russian River during inspection and maintenance activities that took place in the fall. However, during inspection and maintenance in June 1999, no stranding or rescue was necessary, as pools were maintained on the East Fork to provide refuge. The presence of pools and lack of stranding may have been due in part to dewatering of the stilling basin, which provided about 1 cfs to 4 cfs for several hours following cessation of releases from the dam. In addition, flow accretion from seepage or groundwater contributions may have also maintained pools and a small streamflow. Flow downstream of the Forks near Ukiah on the mainstem Russian River was at least 14 cfs.

Use of the current 50-cfs/hr ramping rate during pre-flood inspections and maintenance activities at CVD does not provide protection from stranding for either fry or juveniles. Ramping effects may be observed in the East Fork and mainstem Russian River for several miles below the Forks. CVD operations will not significantly affect listed species on the mainstem Russian River below the Forks during maintenance and inspection activities if there is sufficient flow at the Ukiah gage. However, lack of bypass flow capability may cause dewatering and stranding on the East Fork.

Coyote Valley Dam Flood Control Operations

On the mainstem Russian River, ramping effects during flood control operations were evaluated from about 3 miles below CVD to 5 miles below the dam, using hydrologic modeling at four cross-sections in this reach (no cross-sections are available closer than 3 miles from the dam) (ENTRIX, Inc. 2000a). A stage change of 0.16 ft/hr or less was used as a conservative criterion for protection for juvenile fish.

At CVD, the results of hydrologic modeling indicate that none of the four cross-sections in the upper Russian River could achieve the 0.16 feet per hour (ft/hr) criterion at 250 cfs/hr ramping rates, nor could they achieve the stage change within 100 percent of the criterion (ENTRIX, Inc. 2000d). Change in stage was generally 0.5 ft/hr or more when ramping at 250-cfs/hr increments.

However, CVD is usually operated within the 250 cfs/hr interim ramping rate only when reservoir outflows are 1,000 cfs to 250 cfs. Under these conditions, the risk of stranding due to dewatering is lower. At the Forks, there is usually considerable flow from the mainstem Russian River that would attenuate ramping effects. Often flows are greater than 2,500 cfs at the Forks during flood operations ramp-down, and there is a backwater effect on the East Fork, which would attenuate stage changes (P. Pugner, USACE, pers. comm., 2000). Results were similar for stage changes associated with 125-cfs/hr flow reductions when reservoir release flows were between 250 cfs to 0 cfs. The conclusion is that ramping rates associated with flood control operations provide adequate protection to listed fish species.

Mirabel Inflatable Dam

When the inflatable dam is lowered, flow recessions in approximately 3.2 miles of river upstream have the potential to result in stranding or displacement of salmonids. The risk of stranding is highest during a spring deflation of the dam because juvenile fish are more likely to be present. Several factors reduce this risk.

At the current rate of dam deflation, the stage change is estimated at about 0.46 ft/hr. When the dam is lowered at the onset of the rainy season in response to increasing flows associated with storm events, this stage change is likely to be attenuated, which reduces the risk of stranding. Spring deflation of the dam is almost always in response to rising river flows, which also results in no net dewatering of habitat. Furthermore, the inflatable dam is lowered infrequently. It was lowered on average only 1.5 times per year over a recent 20-year period.

Generally, habitat in the two-mile reach that is affected by impounded water above the inflatable dam does not have characteristics that increase the potential for stranding. When the inflatable dam is not inflated, the channel upstream of the dam is primarily run-habitat, with fine gravel, cobble, and boulder substrates. It is a single-channel river that has a relatively straight trajectory through the area and relatively few structural features that would create low areas outside of the main channel. The slopes of the river margins have a low-gradient, which could increase the risk of stranding, but are sloped to the main channel. The wetted channel extends from bank to bank whether the dam is inflated or deflated, so it is unlikely that dewatering of the riverbed is a concern. In general, the channel geomorphology upstream of the dam presents little risk of stranding, and dewatering of the riverbed is unlikely.

2.10.1.2 Entrainment and Impingement

Operations of SCWA's diversion facilities at Mirabel and Wohler potentially result in impingement or entrainment of listed fish species. Fish may also be entrained in the infiltration ponds when flood flows overtop the levees.

The fish screens at the Mirabel diversion conform to most of the NOAA Fisheries screening criteria for protecting juvenile life stages of salmonid species, but not for fry. The timing of the Mirabel diversion operation normally does not overlap substantially with the juvenile outmigration period for coho and Chinook salmon. The risk for juvenile steelhead is slightly higher, because there is a larger overlap with diversion operation and juvenile outmigration period. Steelhead fry that may be present are at risk. However, because steelhead rearing in this area is limited by high summer water temperatures, the overall effect to the rearing life-history stage (fry or juveniles) may be low.

The Wohler diversion system is considerably smaller than the one at Mirabel, but is ineffectively screened. When water is diverted to the Wohler infiltration ponds, fry and juvenile salmonids that are rearing or migrating through the area are at risk. Migrating juveniles of all three listed species, particularly steelhead, may be affected.

When flood flows overtop the infiltration ponds at Mirabel and Wohler, juvenile fish can be entrained. Because the Mirabel ponds overtop infrequently, migrating salmonids are at a low risk, and recent modifications for more effective fish-rescue efforts minimize this risk.

Prior to 1999, fry and juvenile salmonids could become trapped in the Wohler ponds when stormflows overtopped the levees surrounding the ponds. Because the Wohler ponds historically overtopped more frequently, migrating salmonids were at a higher risk of entrainment. While fish-rescue operations may have reduced the risk, some juvenile steelhead have been lost to injury or stress during rescue operations. Fish rescues were conducted after the levees overtopped, but at times they were delayed for up to two weeks until access was possible.

2.10.1.3 Impediments or Barriers to Outmigration

The Mirabel inflatable dam does not impede adult salmonid passage while lowered, and when in operation, the fish ladders are effective at passing adults of all species without delay.

The inflatable dam has been identified as a potential impediment to smolt outmigration. When inflated, the dam at Mirabel impounds water for 3.2 miles upstream. This impoundment decreases current velocity, which has the potential to delay emigrating smolts. Data from SCWA's five-year monitoring program suggest that smolts that are physiologically prepared to emigrate experience a minor delay through the impounded area, but the delay seems to occur primarily at the dam. Recent studies by SCWA (Manning et al. 2000, 2003) have shown that steelhead smolts tend to accumulate above the dam and are reluctant to use the fish ladders, but most fish pass successfully. Chinook salmon smolt emigration through the area does not appear to be delayed by the dam (Chase et al. 2002).

2.10.2 Effects Related to Water Management

2.10.2.1 Summer Flows

The streamflows in the Russian River that have resulted from the minimum instream flow requirements of D1610 are dramatically different from the natural flow regime of the river, particularly during the dry season. Effects related to water management occur primarily during the summer salmonid rearing season.

Based on the analyses of the effects of D1610 flows presented in *Interim Report 3* (ENTRIX, Inc. 2002a) and a habitat/flow study conducted in the fall of 2001 (ENTRIX, Inc. 2002b), the following issues were identified:

- Water velocities in Dry Creek and in the upper mainstem of the Russian River are higher than optimum for salmonid rearing.
- Storage levels in Lake Mendocino may be inadequate to maintain a cold-water pool sufficient to regulate temperatures in the upper Russian River during the late summer and early fall.
- Expanded warmwater habitat in the middle and lower Russian River favor fish species that prey on or compete with steelhead and salmon.
- In the Estuary, an artificial sandbar breaching program is required to prevent flooding of local property in the summer months.

The Estuary is important for adult and juvenile passage for all three listed species and may provide important rearing habitat for steelhead and Chinook salmon. The current summer flow regime has the potential to affect several components of salmonid habitat in the Estuary. These include water quality (including temperature, DO, and salinity), primary productivity and the availability of aquatic invertebrates, availability of shallow water habitat, and the concentration of nutrients and toxic runoff. Augmented summer flow results in the need for an artificial breaching program that may also affect these components, and may allow adult salmonids early access to the river when flows and temperature may be unsuitable.

Infrequent breaching of lagoons, especially during low-flow summer months, impairs water quality because a long transition period with salinity stratification results in high water temperatures and low DO levels in deeper water layers (Smith 1990). However, the augmented flow in the Estuary has several beneficial effects including the dilution of agricultural and urban runoff and dilution of untreated waste from failing on-site sewage disposal systems throughout the watershed.

2.10.2.2 Winter flows

Operations at CVD and WSD regulate flood flows during winter storms. The dams moderate the naturally flashy conditions by reducing peak flows and maximum ramping rates. There are three issues related to potential effects on channel geomorphic conditions: scour of spawning gravels, streambank erosion, and channel maintenance/geomorphology. Sufficient flows should be available to maintain channel geomorphology for high-quality fish habitat, but high flows can scour spawning gravels and redds, as well as contribute to excessive bank erosion. Effects of flood control operations were evaluated in *Interim Report 1* (ENTRIX, Inc. 2000a).

The evaluation indicates winter flows in the mainstem Russian River are sufficient to mobilize and flush spawning gravels, which maintains good quality spawning habitat. Flood control operations do not have a significant effect on spawning gravel scour in the middle or upper reaches of the Russian River. However, flows in Dry Creek below WSD can be strong enough to scour redds and mobilize spawning gravels.

On the mainstem Russian River, potential effects of flood flows were evaluated for steelhead and Chinook salmon only, since coho salmon do not use the mainstem for spawning. The upper and middle reaches, between Ukiah and Alexander Valley, were included in the assessment. Downstream of Alexander Valley, spawning habitat is limited (Winzler and Kelly 1978, Cook 2003b), and flood control operations have a diminishing effect on high-flow conditions; so the lower mainstem reach was not considered for evaluation.

The evaluation indicates that stability of steelhead spawning gravels is very good in the upper mainstem reach. There is a moderate potential for scour of Chinook salmon gravels, but there is an acceptable balance between periodic streambed mobilization and spawning gravel stability. The lower incidence of scour of steelhead gravels compared with Chinook salmon gravels is at least partially due to the later-season incubation period for steelhead. The incidence of flows that might scour spawning gravels later in the season when steelhead are incubating is fairly low on the upper reach.

In the middle reach of the Russian River at Alexander Valley, spawning gravels are less stable and subject to slightly more frequent scour than the upper reach. The evaluation indicates moderately stable conditions for Chinook salmon, and moderately, but slightly less stable conditions, for steelhead. Higher discharges due to tributary flow accretion probably account for the greater incidence of scour in the middle reach compared with the upper reach.

On Dry Creek, effects of flood control operations were evaluated for coho salmon, steelhead, and Chinook salmon. There is a reasonably good balance between expected periodic streambed mobilization and spawning gravel stability for successful reproduction of Chinook salmon, and an acceptable balance for successful coho salmon and steelhead reproduction. Coho salmon, which use smaller gravels for spawning, would be subject to a greater frequency of scour than either steelhead or Chinook salmon redds.

2.10.3 Channel Maintenance Activities

Interim Report 5 (ENTRIX, Inc. 2001c) identified several adverse modifications to salmonid habitat due to channel maintenance activities in constructed flood channels. These maintenance activities include sediment maintenance and vegetation maintenance.

Sediment maintenance in constructed flood control channels reduces fish passage to spawning and rearing habitat and restricts downstream migration. However, most sediment maintenance occurs in channels in urbanized areas where low summer flows reduce water quality and there is poor summer rearing habitat. Therefore, sediment maintenance actions have only limited effects.

Vegetation maintenance occurs in constructed flood control channels, and to a more limited extent, in natural waterways. The urbanized portion of the watershed in Santa Rosa and the Cotati-Rohnert Park areas contain most of the constructed flood control channels. Natural waterways and constructed flood control channels in the Rohnert Park area are generally low-gradient, run through a valley plain to the Laguna de Santa Rosa, and contain poor summer rearing habitat. The Laguna de Santa Rosa has important wetland and flood control functions for this part of the watershed. Santa Rosa Creek also drains to the Laguna de Santa Rosa, which, in turn, drains to Mark West Creek. Channel maintenance activities on constructed and natural waterways in this part of the Mark West Creek watershed, including the Santa Rosa Creek watershed, have the potential to affect coho salmon and steelhead because this area contains good rearing and spawning habitat for these species.

SCWA and MCRRFCD channel maintenance activities related to USACE obligations for flood control structures occur in Dry Creek and the mainstem Russian River in Sonoma and Mendocino counties. Loss of riparian vegetation due to maintenance of bank stabilization structures under USACE obligations on Dry Creek and the mainstem Russian River may have a moderate effect when shade canopy and cover are reduced.

SCWA and MCRRFCD have conducted activities in the mainstem of the Russian River related to streambank stabilization. These activities, as conducted under baseline practices, potentially have a substantial effect on populations of listed fish species because habitat in large amounts of river and stream channel can be altered. This is particularly true upstream of Asti in Mendocino County because some of the most valuable mainstem rearing and spawning habitat occurs there. Gravel bar grading and vegetation removal potentially affects listed fish species by reducing pool habitat formation and loss of high-flow refuge, as well as reducing shade canopy and cover.

2.10.3.1 Other Factors Influencing Species Environment

Water supply operations at WSD and CVD are not likely to increase the risk of predation on listed species. Cool water releases downstream of the dams favor cold water species rather than the warmwater fish community that can compete with or prey on listed fish species.

Operation of the inflatable dam may slightly increase the risk of predation on migrating Chinook salmon or a few rearing steelhead. YOY steelhead have been found in the area, but not YOY coho salmon. The inflatable dam impounds water, resulting in an increase in pool habitat that has the potential to increase habitat for the warmwater fish community, including predators. This potentially increases the risk of predation on migrating juveniles. The ability of predators to consume juvenile salmonids depends on their relative sizes; larger predators are most likely to prey on young fish. Preliminary sampling in the Wohler Pool in 1999 found predators (e.g., smallmouth bass) in vastly larger numbers in young-age classes than older-age classes. However, older, larger predators that can prey on young salmonids were found in very low numbers.

Temperature monitoring in both the impounded area and in the free-flowing river areas found favorable temperatures for warmwater predator populations. However, monitoring studies also found the impoundment created by the inflatable dam was not responsible; water temperature increased only slightly (about 0.5°C) above water temperature upstream of the impoundment.

2.10.4 Fish Production Facilities

Hatcheries may have adverse effects on listed fish species. Hatchery-bred fish may affect naturally reproducing stocks through competition, predation, and effects to genetic integrity. Evaluation of hatchery operations in *Interim Report 2* (FishPro and ENTRIX, Inc., 2000) indicated that, in general, there is a low risk of adverse effects to listed fish populations

Given the mixed stock history of DCFH and CVFF, adult salmonids currently returning to the facility may be of mixed origin. Therefore, the risk of outbreeding depression is potentially higher than would be the case had broodstock always been collected locally. Over the last four years of the Chinook salmon program, the numbers of female Chinook salmon returning to the hatchery decreased considerably, reflecting the shift to local broodstock rather than out-of-basin sources. The numbers of Chinook salmon spawned during that time was well below the suggested minimum of 100 adult pairs, and, therefore, hatchery Chinook salmon may have had an unfavorable level of inbreeding. There is a low risk of artificial selection in the hatchery program because traditional rearing techniques are used and because the naturally spawned individuals are not used as broodstock. Hatchery production of steelhead may contribute to competition with naturally spawned steelhead, and there is a risk that hatchery fish may prey on listed natural fish because they are released at a larger size. However, steelhead releases are not generally made in primary spawning or rearing habitat, and the volitional release strategies employed at CVFF minimize the risk even further.

Operating practices of the DCFH and CVFF facilities reflect a commitment to minimizing effects on listed populations. The facilities maintain good track records on the ability to manage routine fish diseases, and recent changes in policy regarding importation of stocks have resulted in minimal likelihood of effects on listed stocks through disease. Current operations relating to production goals and harvest indicate the best practicable approach to minimizing ecological effects such as competition, predation, and overexploitation. Procedures for waste treatment demonstrate continuous compliance with recommended discharge standards for water quality.

USACE, SCWA, and MCRRFCD will continue to implement many activities currently in place as described in Section 2, Environmental Baseline. These agencies also propose modification to existing operations to benefit listed salmonids within the Russian River watershed. The project will include both structural modifications to existing facilities and operational changes at the facilities.

This section focuses on the descriptions of those facilities and operations that would change relative to the baseline conditions if the project is implemented. The project descriptions reference appropriate portions of Section 2 that will not change. This section is organized as follows.

Section 3.1 describes the modifications to flood control and the water storage facilities located at Lake Sonoma and Lake Mendocino, the water diversion facilities at Mirabel and Wohler, and the transmission system that distributes the water. The descriptions of operations and maintenance identify changes that are intended to improve habitat conditions for listed salmonids, and reduce the opportunity for impingement and entrainment.

Section 3.2 describes the changes that are proposed to the management of flow in the mainstem Russian River and Dry Creek. The objective of the flow management proposal is to improve rearing conditions for salmonids in the Russian River, Dry Creek, and the Estuary. This section also presents some alternatives for changes in the way SCWA transports or diverts water from the dams and the Russian River.

Section 3.3 describes the management of water levels in the Estuary with the goal of allowing the sandbar to remain closed during the summer months.

Section 3.4 describes the manner by which SCWA and MCRRFCD would conduct channel maintenance activities in the mainstem Russian River, constructed flood control channels and tributaries. The proposed operations seek to balance habitat development and flood control.

Section 3.5 describes the proposed changes to operations and facilities at the fish production facilities. The proposed operations implement a coho salmon conservation hatchery program, modify the steelhead mitigation program, and provide for a future Chinook salmon recovery program. The coho salmon program would function as an integrated recovery program and would include a captive broodstock program. The steelhead program would be operated as an isolated harvest program and would maintain the existing production and release goals. No production of Chinook salmon is presently proposed. However, future monitoring may indicate that a Chinook salmon recovery program is warranted.

Section 3.6 describes restoration actions that are being undertaken by SCWA since the signing of the MOU. These efforts include watershed management; riparian and aquatic habitat protection, restoration, and enhancement; and water conservation and recycling.

The proposed project is subject to a number of legal constraints and agreements, which are discussed in Section 1.4. These agreements may constrain the extent to which, absent regulatory approvals and/or changes to the agreements, USACE and SCWA are able to implement conservation measures, reasonable and prudent measures, and conservation recommendations to be developed by NOAA Fisheries in the BO for the consultation. Therefore, implementation of the proposed changes may require modification or revision of the existing institutional agreements. The agreements requiring modification are identified in Section 3.7.

USACE and SCWA are also proposing monitoring efforts to assess the effectiveness of the proposed actions on improving environmental conditions for listed salmonids, where appropriate.

3.1 FLOOD CONTROL, WATER STORAGE, AND SUPPLY OPERATIONS

This section discusses proposed changes and upgrades to the physical components of the water storage and supply facilities.

Three major reservoir projects provide water supply storage for the Russian River watershed: Lake Pillsbury on the Eel River, Lake Mendocino, and Lake Sonoma (Figure 2-1). Lake Pillsbury is part of the PVP operated by PG&E, and its operations under the authorization of FERC are being addressed in a separate Section 7 consultation between NOAA Fisheries and FERC (NMFS 2000a). This BA does not propose any changes to the operation of the PVP, but incorporates the proposed water deliveries to the Russian River project. Significant changes to the release criteria and minimum flow provisions in the 1983 FERC permit for the PVP have been proposed by various parties, and are the subject of the BO from NOAA Fisheries and an EIS prepared by FERC.

3.1.1 COYOTE VALLEY DAM AND LAKE MENDOCINO

The purpose of Lake Mendocino is to provide flood protection to areas downstream of CVD and water supplies for domestic, municipal, industrial, and agricultural uses. Lake Mendocino impounds water from the East Fork Russian River and receives water from the PVP. CVD began storing water in 1959. Lake Mendocino has a 122,500 AF design capacity, and regulates flood runoff from a 105-square-mile basin. The water supply pool capacity of Lake Mendocino is about 69,000 AF[1]. SCWA will continue to manage releases made from the water supply pool; however, when the water level rises above the top of the water supply pool (seasonally between elevations 737.5 feet and 748 feet above MSL) and into the flood control pool, USACE will manage releases. USACE also manages releases during annual inspections and during maintenance and repair of the project. Following formal notification from USACE to SCWA of planned inspections or

[1]All storage volumes discussed in this report are the 1985 bathymetric survey values reported by SCWA.

maintenance, SCWA will notify affected regulatory agencies including FERC and SWRCB. USACE will notify NOAA Fisheries directly of the planned work. CVD facilities (and current operations) are described in Section 2.3.

3.1.1.1 Flood Control Operations of Coyote Valley Dam

USACE's primary objective for flood control releases from Lake Mendocino is to continue to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below CVD. To the extent possible, USACE will limit releases from Lake Mendocino to prevent local flooding at Hopland, which generally occurs when flows in the Russian River exceed 8,000 cfs. Because bank sloughing is likely to occur when flows decrease too rapidly, USACE will limit the reduction in releases from Lake Mendocino to 1,000 cfs/h or less. Winter operations will include flood storage until the dedicated flood storage space is reached and flood control releases are made as described below.

The specific criteria for CVD flood control operations were revised in the Water Control Manual (Exhibit A, USACE, 2003). The general criteria for releases from the flood control pool, which includes all reservoir storage above the top of the water conservation pool, call for successively increasing releases in three stages as reservoir levels rise toward the emergency spillway. The operations provide for the greatest monthly reductions in lake level during late spring and early summer. When possible, releases from CVD will be controlled so that flow at Hopland, about 14 miles downstream, does not exceed the 8,000-cfs channel capacity. However, maintaining flows of 8,000 cfs or lower at Hopland is not possible when inflow to Lake Mendocino is very high.

Specific directions for flood control operation are described by the Flood Control Diagram included in Exhibit A of the titled “Standing Instructions to Damtenders” (CVD Standing Instructions) as follows:

> *Flood Control Schedules 1, 2, and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at the Russian River near Hopland to exceed 8,000 cfs, and (2) the discharge that results in flow at Hopland being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the event or events, which caused the highest pool at Lake Mendocino. In addition, releases will be limited to (1) up to 4,000 cfs if the reservoir pool did not reach elevation 746.0 feet, (2) 4,000 cfs if the highest reservoir pool reached was between elevation 746.0 feet and 755.0 feet, and (3) up to a maximum of 6,400 cfs if the pool exceeded elevation 755.0 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. Schedules 1, 2, and 3 are used if no significant rainfall is predicted.*
>
> *When the QPF is 1 inch or more for the next 24 hours or 1/2 inch or more for any 6-hour period in the next 24 hours, and releases exceed 1000 cfs, flows in the Russian River will be monitored, to ensure dam operations adhere to all other limitation and operating criteria. Also, when the flow*

in the Russian River at Ukiah exceeds 2,500 cfs and is rising, releases from Lake Mendocino will be reduced to 25 cfs, insofar as possible.

Outlet gates may be used for Flood Control Schedule 3 releases when the pool is above the spillway crest (elevation 764.8 feet); however, the sum of the spill and the releases must not exceed 6,400 cfs, subject to the above limitations.

The Emergency Release Schedule is used between elevation 764.7 feet and 773.0 feet, at which stage the flood control gates are fully opened. The flood control gates will remain fully open until the reservoir pool has receded to elevation 764.7 feet, at which time the release schedule 3 is implemented.

3.1.1.2 CVD Maintenance and Inspection Activities

Annual and periodic (5-year) pre-flood inspections as described in Section 2.3 would continue for the CVD facilities. Two issues arose in the evaluation of the potential effects of maintenance and inspection activities: timing of inspections and flow reduction during inspections and maintenance activities. To address these issues, structural modifications would be made at the dam and changes in timing and operations during inspection and maintenance would be implemented.

In the past, annual inspections at CVD required that flows through the dam cease for approximately two hours, and periodic (5-year) inspections require flow cessation up to six hours. To perform periodic maintenance or repairs identified during inspections, flows through the dam may need to be reduced or shut down for longer periods ranging from one hour to several days. During these inspections in the past, the East Fork Russian River has been subjected to dewatering, and flows have been reduced in the Russian River downstream of the confluence with the East Fork.

To avoid dewatering the East Fork, USACE proposed to modify the CVD facilities to allow a bypass flow of 25 cfs during inspection and maintenance. USACE is evaluating the installation of two pumps, approximately 250 hp each, to provide approximately 25-cfs flow in the East Fork Russian River. The bypass pumps would be attached to the outside of the control tower at CVD and would draw water directly from the reservoir. The water would pass through a small pipeline and would be discharged downstream of the weir below the dam. USACE anticipates incorporating the bypass pipeline into the bridge to the control tower. The pumps will be operated as independent systems, thereby maintaining flow should one of the pumps fail. The pumps would be operated during periods when maintenance and inspection activities are being conducted. This action would provide an uninterrupted flow of good quality water when the pumps are operating.

Construction of the bypass pipeline provides an opportunity to provide reliable water supply to the fish hatchery during maintenance activities or emergency repairs if the fish facility is in operation. A 15-cfs release from the bypass pipeline would be provided to supply water to the fish-rearing facility at the base of the dam.

In 1998 and 1999, inspections at CVD took place in September and June, respectively. In 2000, pre-flood inspection took place in May. During inspections, flows must be reduced or completely shut down. During previous inspections, interruption of flows has affected young salmonids in the East Fork Russian River and the portion of the mainstem Russian River just below the confluence with the East Fork. To minimize the potential for routine maintenance and inspections to adversely affect salmonid fry, USACE will conduct such activities when young salmonid fry are not likely to be abundant. USACE proposes to schedule routine maintenance and inspection activities between July 15 and October 15. Shifting routine inspection and maintenance work to avoid May and June would allow the young salmonids in the reaches potentially affected to grow to a larger size so they are better able to avoid being stranded during declining flows.

3.1.1.3 Ramping Rates

Flows are ramped down during flood releases and in preparation for maintenance and inspection conducted in the summer and fall. USACE developed interim guidelines for flow release changes in consultation with NOAA Fisheries and CDFG described in Table 2-12. The evaluation of ramping rates for CVD provided in *Interim Report 1* indicated that protection of young salmonids could be improved if ramping rates for flows below 250 cfs were modified (ENTRIX, Inc. 2000a). Under the proposed operations, the USACE proposes to modify the ramping schedule for CVD and change the outlet structure to allow greater control over the gate opening. When flows in the mainstem Russian River at Ukiah are less than 1,000 cfs and releases from CVD are less than 250 cfs, the ramping rates during decreasing releases would be reduced to 25 cfs/h (Table 3-1). To improve the ability to regulate flow changes of this level, USACE would install new automated controls to facilitate closing the outlet gates to meet the proposed ramping rates.

Table 3-1 Coyote Valley Dam Ramping Rates

Reservoir Outflow	Proposed Ramping Rates
0-250 cfs	25 cfs/h
250-1,000 cfs	250 cfs/h
>1,000 cfs	1,000 cfs/h

3.1.1.4 Hydroelectric Operations

The hydroelectric power generation facility located at the base of CVD would continue to be operated by the City of Ukiah, independently of water supply operations, as described in Section 2.3. Under this proposal, structural modifications would be made to reduce the effects of flow reductions during the initiation or cessation of hydroelectric operations.

In the past, flow releases through the CVD were halted for approximately five hours to allow switching of the Tainter gate before hydroelectric operations were initiated or terminated. To avoid dewatering the East Fork of the Russian River, the bypass pumps would be used to provide flow in the East Fork Russian River during transitions to, or from, hydroelectric operations.

3.1.2 Warm Springs Dam and Lake Sonoma

Lake Sonoma is located at the confluence of Warm Springs Creek and Dry Creek, about 10 miles northwest of the City of Healdsburg (Figure 2-1). Existing WSD facilities are described in Section 2.4.

3.1.2.1 Flood Control Operations of Warm Springs Dam

USACE will continue to determine water releases when the water level rises above the top of the water supply pool (elevation 451 feet above MSL) and into the flood control pool. To the extent possible, USACE limits releases from Lake Sonoma to restrict flows on the Russian River at Guerneville to 35,000 cfs, which is the approximate channel capacity in Guerneville. USACE also limits releases to prevent flooding downstream along Dry Creek, which generally occurs when flows just below the dam exceed 6,000 cfs.

The criteria for flood control operation of Lake Sonoma are similar to those for Lake Mendocino and were revised in the Warm Springs Dam Water Control Manual (WSD Water Control Manual) (USACE 2003b). Releases from the flood control pool include all reservoir storage above elevation 451.1 feet MSL. As with Lake Mendocino, flood control includes three successive flood release schedules. For Lake Sonoma, the Hacienda Bridge gage, located approximately 16 miles downstream of WSD, is the most downstream monitoring point for decisions affecting flood control releases from Lake Sonoma.

Specific directions for flood control operation are described by the Flood Control Diagram included in Exhibit A to the WSD Water Control Manual, titled “Standing Instructions to Damtenders” (WSD Standing Instructions) as follows:

> *Flood Control Schedule 1, 2, and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at Dry Creek near Geyserville gage (Yoakim Bridge) to exceed 7,000 cfs and/or flow at the Russian River near Guerneville gage to exceed 35,000 cfs, and (2) the discharge that results in flow at Guerneville being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the event or events that caused the highest pool at Lake Sonoma. In addition, releases will be limited to a maximum of: (1) 2,000 cfs if the reservoir pool did not reach elevation 456.7 feet, (2) 4,000 cfs if the highest reservoir pool reached was between elevation 456.7 feet and 468.9 feet, and (3) 6,000 cfs if the pool exceeded elevation 468.9 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. When the pool elevation is at or below 502.0 feet and inflow*

is at or above 5,000 cfs no gate releases will be made. Schedules 1, 2, and 3 are used only if no significant rainfall is forecasted.

Rain forecasts are considered significant when the QPF is 1 inch or more for the next 24 hours or ½ inch or more for any 6-hour period in the next 24 hours and releases exceed 1,000 cfs, flows in Dry Creek and the Russian River will be monitored hourly so that reductions in releases from Warm Springs Dam can be made to ensure dam operations will adhere to all other limitations and operating criteria.

Flood Control Schedule 3 releases will be maintained until elevation 502.0 feet is reached. This is done by regulation the outlet so that the combined flow from spills (pool above elevation 495.0 feet) and releases through the outlet works does not exceed 6,000 cfs.

The Emergency Release Schedule is used about elevation 502.0 feet (153.0 m) at elevation 505.0 feet (153.9 m) the flood control gates will be fully opened.

3.1.2.2 Water Supply to Fish Facilities

Several engineering options are being considered to provide a more consistent supply of water to the DCFH. The existing water supply pipeline could be replaced with an engineered pipeline that would be incorporated into the wall of the flood control outlet works. Alternatively, a pipeline stub could be installed in the wet well and exit the face of the dam. This pipeline stub would allow water to be tapped directly from the wet well for hatchery supply, and for other uses in the future. These uses may include hydroelectric operations and water supply.

Water released from Lake Sonoma can be taken from four different intake portals, each at a different elevation in the lake. Three intake portals are located in the left abutment of the dam, while the fourth portal is located near the bottom of the reservoir. Water from different portals will be mixed to optimize water temperature, DO levels, and turbidity. The selection of water intake levels will be determined by USACE in coordination with CDFG to meet the water quality needs of the fish production facility. This will control the water quality of releases to Dry Creek as well. Although four low-flow tunnels are available, the lowermost has very low DO and is too turbid to be used for water supply to the hatchery.

Under baseline conditions, the uppermost tunnel was plugged with concrete. The plug was removed in 2002 (P. Pugner, pers. comm. 2003). Repair and cleaning of this upper water discharge tunnel will allow more flexibility in meeting water quality requirements at the DCFH and in Dry Creek.

3.1.2.3 Maintenance and Inspection Activities

The maintenance and inspection activities described in Section 2.4 at WSD would continue. The changes in timing and ramping rates described in Section 3.1.1.3 would be implemented for inspection at WSD. When releases from the dam are less than 250 cfs, they will be ramped down at 25 cfs/h or less. A bypass flow of 25 cfs will continue to be provided during maintenance and inspection activities.

3.1.2.4 Hydroelectric Operations

The operation of the hydroelectric facility is described in Section 2.4. The hydroelectric project is operated using water delivered for water supply. The reductions in releases from WSD (as described in Section 3.2) would reduce the quantity of hydroelectric generation. Changes to flow releases as proposed would require the concurrence of FERC, and modifications to the terms and conditions of the FERC license for Project No. 3351-002 (see Section 3.7.2).

3.1.3 Diversion Facility Operations

Under the proposed project, SCWA would continue to divert and deliver water to its customers through the water transmission system. SCWA's diversion facilities are located near Wohler and Mirabel, on SCWA property. SCWA operates five Ranney collector wells and seven conventional wells adjacent to the Russian River, which extract underflow from the aquifer beneath the streambed. A sixth Ranney collector well, located in the Wohler area, is expected to begin operation in 2004. SCWA operates five infiltration ponds near Mirabel and two infiltration ponds near Wohler. The ponds recharge the aquifer to create a reliable water supply to the Ranney collector wells.

3.1.3.1 Studies at the Mirabel Diversion Facility

SCWA staff initiated a five-year monitoring study of the diversion facilities in April 1999 to investigate the potential effects of the inflatable dam on local fish populations (Chase et al. 2000, 2001). Information collected during this study will be used to reduce potential effects to listed fish species. Data from the study have provided valuable information on life histories of the listed fish species (see Section 2.2.4).

Components of the study include:

- Habitat mapping in the area affected by the inflatable dam
- Smolt emigration issues
- Adult salmonid upstream migration issues
- Water quality effects
- Gravel bar grading effects
- Predator species population assessment

The Mirabel inflatable dam impounds a 3.2-mile section of the river known as the Wohler Pool. Within the impounded reach, water depth is increased and current velocity is decreased. These changes in the natural hydrology of the river may potentially alter fish species composition, distribution, and abundance. The study is specifically designed to assess the effects of the operation of the dam. Trapping, radiotelemetry, video monitoring, and electrofishing are used to sample fish life stages throughout the year.

Study results indicate that the inflatable dam does not impede adult salmonid passage while lowered. When in operation, the fish ladders are effective at passing adults of all species without delay.

Adult salmonid migration past the inflatable dam would continue to be monitored during the five-year study period using video equipment installed at the fish ladders. The operation of the video equipment could delay juveniles migrating downstream by preventing them from using the fish ladders. This would be addressed by altering the timing of the video monitoring. Equipment is currently installed in August, after downstream juvenile migration is complete, avoiding a delay in smolt migration. In addition, adult salmonids have not been observed in the river before late August.

In 1999, SCWA completed the first season of downstream migrant trapping using a rotary screw trap. To determine whether the dam was causing a delay in migration, more than 9,000 steelhead smolts from the DCFH were marked with fluorescent dye and released above the dam. Although few marked fish were recaptured, trapping revealed important information about the characteristics of smolts emigrating during late spring. The frequent occurrence of juvenile Chinook salmon (a poorly documented species in the Russian River basin) was particularly informative. The trap showed promise for providing information on the timing, size, and age of emigrating smolts, as well as providing a chance to collect tissue samples for DNA analysis.

Data from the monitoring program suggest that smolts migrating downstream may experience a minor delay moving through the diversion facility. Steelhead smolts tend to accumulate above the dam and are reluctant to use the fish ladders, but most fish pass successfully (Manning et al. 2003). Chinook salmon smolt emigration through the area does not appear to be delayed by the dam (Chase et al. 2002).

A performance evaluation of the Mirabel diversion fish screens indicated that although most of the critical operating parameters and engineering design criteria meet NOAA Fisheries screening criteria for juvenile salmonids, there are some “hot spots” where approach velocities are too high (Borcalli & Associates 2000). NOAA Fisheries screening criteria for fry are generally not met. The fish screen at the Wohler diversion did not meet NOAA Fisheries screening criteria.

3.1.3.2 Mirabel Diversion Facility Modifications and Operation

The Mirabel diversion facilities (located at RM 24.6), include an inflatable dam and concrete foundation, an intake structure equipped with two rotating fish screens, a pump caisson and control structure, conveyance piping, an outlet structure, and two Denil fish ladders at opposing sides of the river. These facilities are described in Section 2.5. *Interim Report 4* identified several areas where the Mirabel diversion facilities and operations could be improved. The operational changes would be associated with ramping rates during dam inflation and facility improvements to the fish screens, outlet, fish ladders, and inflatable dam. Modifications to the inflatable dam and diversion facility would be undertaken to reduce the potential for entrainment and impingement of listed species, and to speed outmigration of smolts.

Water Diversion Operations at Mirabel

Water diversion operations would generally continue according to previous practices. SCWA relies on the operation of the inflatable dam and the Mirabel and Wohler facilities to meet the water demand for water supplies. The inflatable dam will continue to be operated at the Mirabel diversion facility to raise the water level in the river, increase the rate of aquifer recharge, and facilitate the diversion of water into the infiltration ponds. The inflatable dam is typically raised in May and lowered in October-November (Table 2-14). The dam may be raised as early as March, and lowered as late as January, depending on water supply conditions. As demand increases under projected future demand, these facilities will be increasingly relied upon to meet peak demands in the spring and fall months as well as the summer period. When inflated, the dam impounds water for approximately 3.2 miles (5.1 km) upstream, creating the Wohler Pool. The increased pressure head and wetted area result in increased recharge to the underlying aquifer.

When the inflatable dam is raised, water levels below the structure can drop, creating an opportunity for stranding juvenile fish in the channel downstream of the structure. Ramping rates associated with flow reductions during inflation of the dam would be reduced to minimize the potential for stranding of juvenile salmonids. Studies would be conducted to determine the operations at Mirabel that would be protective of juvenile salmonids in the channel affected by reduced flow levels. The rate of flow reduction downstream of Mirabel would depend on the ability to regulate the inflation of the dam and on observations of stage changes and an assessment of stranding potential in the Russian River downstream of the dam. SCWA will evaluate the effects of ramping rates on downstream habitats and develop ramping criteria that are feasible and safe.

Inflatable Dam

As part of its five-year monitoring program, SCWA has assessed salmonid passage past the Mirabel inflatable dam. To address concerns that operation of the dam may delay steelhead downstream migration, studies were conducted to evaluate juvenile steelhead passage under alternative configurations of the Mirabel inflatable dam (Manning et al. 2003).

During 2001, the dam was operated normally and water spilled evenly across the crest of the structure. In 2002, the height of the dam was decreased to concentrate spill depth and velocity. Flow characteristics and smolt responses to three dam configurations were compared: (1) full inflation with a pool elevation of 38.0 feet, (2) partial deflation with an elevation of 37.5 feet, and (3) partial deflation to create a notched effect and elevation of 36.5 feet. Each configuration was alternated throughout the study period and maintained for a total of 2 weeks. In 2002, forebay residence time was much lower than 2001. The reduced forebay time in 2002 was driven by fish releases on May 14 (notch configuration) and May 22 (full inflation).

Median forebay residence time for the notched configuration was an order-of-magnitude lower than full inflation. Small sample size (number of passing fish) may not have yielded enough statistical power to detect differences between the notched and full dam configurations in 2002. Additional evidence suggests the notch may have been effective at reducing forebay residence time despite the inability to reject the null hypothesis of no difference between the full and notched configurations. After removing fish that passed under the notched configuration from the 2002 data, reservoir and forebay residence times were similar. The striking similarities between reservoir and forebay residence times in 2001 and 2002 (after removing fish that passed under the notched configuration) suggested that smolts responded positively to the notch.

Although fish appeared to pass the dam more rapidly under the notched configurations, hydraulic measurements showed little difference between the notched and partially deflated conditions. It is hypothesized that increased velocity and depth created by concentrating spill would accelerate passage. While Acoustic Doppler Current Profiler (ADCP) measurements showed that the two conditions created equivalent velocities, depth at the dam crest appeared to differ between the partially deflated and notched configurations. However, for safety reasons, depth could not be directly measured in the area of concentrated flow at the dam crest. Signal interference associated with the dam also precluded ADCP data collection in the notched portion of the crest.

Operation of the inflatable dam will be modified to reduce the risk of delay during downstream migration for juvenile salmonids. A single depression will be created in the crest of the Mirabel inflatable dam to concentrate the flow of water over the dam. This depression would be in place during juvenile salmonid outmigration periods and would be maintained until smolt outmigration is complete (through July 15). The depression would then be removed and the dam raised to its full height to achieve maximum infiltration. This approach was tested in spring 2002. SCWA and NOAA Fisheries conducted a series of preliminary studies that manipulated the bladder to produce an irregular crest. The team was able to create a stable depression of approximately 1 to 1.5 feet depth in the dam crest at a consistent location (Manning et al. 2003).

The depression will concentrate flow at a point in the midsection of the dam, as opposed to uniform flow over the entire breadth of the dam. This will provide a localized point of discovery for fish trying to move over the dam. The depression will be created by filling the bladder to a base elevation with water and then introducing pressurized air into the bladder. The depression will provide a direct pathway for outmigrating juvenile salmonids to pass over the dam and move downstream, and thereby reduce potential downstream migration delay through the Mirabel facilities.

The action of the water flowing through the depression will create a plunge pool immediately below the base of the dam (S. White, pers. comm. 2003). The pool would provide a place for fish to land after passing over the dam and its presence would reduce the opportunity for injury to fish passing over the dam through the depression.

Intake Facility and Fish Protections

The Mirabel intake structure and fish screens are located on the west bank of the Russian River. They would be reconfigured to comply with NOAA Fisheries and CDFG criteria to provide a screen configuration that prevents impingement and entrainment of fry and juvenile salmonids. The modified intake structure would include flat plate screens and mechanisms for adjusting the relative magnitudes of the approach and sweeping velocities to enable fry and juveniles to swim past the screens and avoid impingement. The intake screen structure would be connected to the existing fish ladder immediately downstream of the proposed screen bank. By directing both diversion flow and fish ladder flow through a single structure, the flows would produce sweeping velocities parallel to the screen face that meet NOAA Fisheries criteria. The combined flow will also make it easier for outmigrating smolts to find their way to the fish ladder. The proposed changes, including preliminary engineering drawings, are described in Borcalli & Associates (2001).

The modified intake structure would provide a transport velocity of approximately 2 fps at the upstream end and, with a minor deceleration over the length of the screen, would have a fish ladder exit velocity of 1.33 fps. These transport velocities would limit juvenile exposure time along the screen bank to less than 60 seconds.

The vertical plate fish screen panels would be integrated into the modified intake structure and fish ladder. The screens will be constructed of wedge-wire with a 50 percent open area. The screens would be cleaned using an electrically operated, traveling brush system that traverses the entire screen bank in both directions. This operation would assist in transporting debris outside the limits of the screen array. The total screen surface area provided would be roughly 450 square feet, 25 percent greater than that required to satisfy the NOAA Fisheries' fish screen criteria for a maximum approach velocity of 0.33 fps. The additional surface area would provide a margin of safety to avoid violation of approach velocity criteria.

Articulating porosity control baffles would be installed in the modified intake structure immediately behind or downstream of the screen panels. The baffles would provide an adjustable means of velocity control with respect to individual, predetermined depth ranges to ensure that localized areas of high velocity would not occur at the screen face. The baffles would require a one-time adjustment and periodic cleaning. The baffle adjustment would be checked each time the dam is raised and inspected annually after the dam has been deflated.

Fish Ladders

The Denil-style fish ladders on each side of the dam are in operation when the dam is raised (see Section 2.5). The fish ladder on the western side of the dam would be integrated into the diversion structure, as discussed in the preceding paragraphs.

Under previous operations, still water created at the upstream entrance to the east ladder may have inhibited the use of the ladder by outmigrating salmonids. Based on preliminary observations in 2002, it appears that the effect of the still water may be ameliorated by the depression in the center portion of the dam (D. Manning, pers. comm. 2003). This may attract fish into the ladder. However, if the still water behind the dam continues to create an impediment for downstream passage through this ladder, the upstream end of this fish ladder would be modified to direct outmigrating salmonids to it. This would be accomplished by moving the upper end of the eastern fish ladder closer to the dam, or by installing a buoyed curtain to exclude juvenile salmonids from the pocket of still water that develops behind the dam. In addition, SCWA plans to modify the east-side bypass pipeline so that it can be operated at its 22-cfs capacity without creating turbulence at the mouth. The west-side bypass pipeline and fish ladder currently function properly.

3.1.3.3 Wohler Diversion Operations and Facilities Modification

The Wohler ponds are an important component of the aquifer recharge system. Part of the year, surface water would continue to be diverted into the two Wohler infiltration ponds to increase water production. The ponds can only be filled when the Mirabel inflatable dam raises the river water surface. *Interim Report 4* identified a concern regarding the potential for listed salmonids migrating downstream to be entrained in the diversion to the Wohler ponds or entrapped in the ponds when the levees are overtopped during storm events (ENTRIX, Inc. 2001a). Modifications to the Wohler ponds would be completed to reduce potential entrapment or stranding of anadromous fish and to prevent entrainment and impingement during the diversion season.

The Wohler diversion facilities consist of two ponds each independently connected to the Russian River by an earthen canal. These canals would continue to function as both inlet and outlet to the ponds. When the Mirabel inflatable dam is raised and the level of the river surface is increased, the ponds can be filled by opening the slide gates. Additional facilities would be constructed at Wohler to provide better protection against entrainment and stranding of listed salmonids in the infiltration ponds. Additional facilities include new intake structures and new fish screens. Modifications of facilities include recontouring of the ponds to reduce the opportunity for fish stranding and promote drainage to the river.

Two interim measures were implemented in 1999. The culverts leading to the ponds are temporarily screened with 3/32-inch punch plates when the infiltration ponds are filled during the summer months. The screens are removed when the Mirabel inflatable dam is lowered. Ponds 1 and 2 are graded to allow the water to drain back towards the inlet pipe as water levels recede. As a result of these interim measures, fish rescues have been concentrated in a much smaller area. Although fish rescues are still conducted, no fish rescues were required in 1999 or 2000.

Wohler Intake Structures

New, permanent, reinforced-concrete intake structures would be constructed at the terminus of the intake canals (Borcalli & Associates 2002). The intake structures would be constructed when the ponds are empty and prior to raising the inflatable dam. The intake structures would facilitate installing and removing the proposed screen modules (described below) and would allow for permanent attachment of the slide gates. The intake structures would be sized to accommodate the screen area required to meet screening criteria. They would be keyed into competent foundation material and would include riprap revetments to maintain stability and soil/structure integrity. The structures would include concrete decks to catch debris removed from the screen face and facilitate its removal and disposal. In addition, the decks would provide all-weather access for gate operation.

Fish Screens

Removable, pre-assembled, self-cleaning fish screen modules would be designed and installed in accordance with NOAA Fisheries and CDFG fish screen criteria. The screen modules would include a self-contained, stainless steel framework; electro-mechanical brush-cleaning systems; and a permanent support infrastructure attached to the intake structures for simple removal and installation. Since the Wohler diversion facilities are located at the ends of their respective side channels, and because there is no practical means of providing bypass flows, sweeping velocities would not exist at the faces of the screens. NOAA Fisheries' fish screen criteria sets forth minimum sweeping velocities, but in cases like this where still water conditions exist, it is not possible to provide sweeping velocities. However, the screens would be sized to provide sufficient protection for fry and juvenile fish. The surface area of the screens would be increased (four to five times required area) to reduce approach velocities well below NOAA Fisheries criteria. These low approach velocities would make it easy for juvenile fish to avoid impingement on the screens.

Power to operate the screen-cleaning apparatus would be provided from the adjacent pump houses. The fish screens would be installed each year before raising the Mirabel inflatable dam. When the ponds are no longer needed to provide increased infiltration and the inflatable dam is lowered, the fish screens would be removed and the ponds drained.

Modification of Operations at Wohler Diversion Facilities

Operations at the Wohler diversion facility are described in Section 2.5. Changes in the operations would center around the new facilities described above and modifications to provide better protection for listed species.

One of the concerns associated with the Wohler ponds is the opportunity for salmonids to become trapped when winter storm flows overtop the levees. Under the proposed project, Wohler Ponds 1 and 2 would be regraded each year so that they have minimal residual volume when drained. The ponds would be regraded to drain towards the inlet pipe, thereby directing any fish present out of the pond. Interim measures completed in 1999 involved the regrading of Pond 2. Pond 1 was regraded in 2000. In addition, during the wet season, the slide gates to the ponds would be left fully open to allow water to drain from the ponds back to the river and to allow salmonids washed into the ponds to escape.

In the past, fish rescues have reduced the potential effects associated with entrapment. Fish rescue operations would continue by wading the ponds with beach seine nets after pond levels drop to a depth where wading is possible.

Regrading the ponds would reduce the necessity of conducting fish rescue operations for juveniles. Furthermore, by limiting rescues to a smaller, shallow area, fish rescues could be conducted more effectively, reducing potential stress to fish. As a result of the regrading of Ponds 1 and 2 and improved interim fish screens, fish rescues were minimized during 2000 and 2001 (S. White, SCWA, pers. comm. 2002b). Fish rescues are still conducted in a small area that is lower in elevation than the outlet of the pond.

The Wohler ponds would need to be periodically regraded as part of normal maintenance activities. Maintenance would also be required to remove accumulated silt and debris to maintain infiltration rates and to ensure that the ponds drain properly.

Operation and maintenance of the Wohler water diversion facilities would entail the following:

1. Annual preparation of the infiltration ponds and diversion facilities
2. Annual removal and installation of the screen modules
3. Maintenance of the screen modules, including cleaning and repair after removal
4. Automatic screen cleaning operations at a user-selectable frequency
5. Manual adjustment of the intake slide gates as needed throughout the infiltration season

3.1.4 TRANSMISSION SYSTEM FACILITIES

SCWA's appropriative water rights permits, as well as present and future water demands, are described in Section 2.5. Transmission system facilities were authorized in the Eleventh Amended Agreement for Water Supply (see Section 1). Some of these facilities have been completed, others are under construction, and others are still in the planning stages. SCWA will continue to operate and construct authorized transmission system facilities, as necessary, to meet current and future water supply demand in the SCWA service area.

Existing diversion, distribution, and treatment facilities were presented in Section 2.5. Remaining authorized and proposed facilities are described here. Remaining authorized facilities are those that were authorized before approval of the WSTSP and are under construction or scheduled for construction in the near future. Remaining authorized facilities are needed to meet existing demand. Proposed facilities are those identified in the WSTSP that will be needed to serve future demands and expand the capacity of the existing water transmission system.

3.1.5 THE WATER SUPPLY AND TRANSMISSION SYSTEM PROJECT

Expansion of the existing transmission system was approved by the SCWA Board of Directors as part of the Water Supply and Transmission System Project (WSTSP) in December 1998. The objective of the expansion is to provide a safe, economical, and reliable water supply to meet future needs in the SCWA service area. The three components of the WSTSP include: 1) implementation of water conservation measures that would result in the savings of approximately 6,600 AFY and expansion of the water education program; 2) increasing the amount of water diverted from the Russian River (a combination of rediversion of stored water and direct diversion of winter flow) by 26,000 AFY, thereby increasing the total amount of diversion and rediversion from 75,000 AFY to approximately 101,000 AFY; 3) increasing the transmission system capacity by 57 mgd, thereby increasing the total capacity of the transmission system from 92 mgd to 149 mgd. Figure 2-23 illustrates conceptual locations of proposed facilities.

3.1.5.1 Remaining Diversion Facilities

Facilities authorized prior to the WSTSP that remain to be completed to meet current demand include 20 mgd of standby pump and collector capacity. SCWA plans to achieve the additional 20 mgd of standby capacity in part through construction of Collector No. 6, a Ranney-type collector well and pumphouse that is currently under construction and expected to commence operation in 2004. Collector No. 6 is located in the Wohler area, adjacent to the Russian River, north of Wohler Bridge and approximately 10 miles west of the city of Santa Rosa. The construction of this facility underwent informal consultation with NOAA Fisheries in 1999 (NMFS 2000b). Ongoing operations and maintenance are addressed in this consultation. The Ranney collector and pumphouse will be similar to the existing Ranney collectors at SCWA’s Mirabel diversion facilities.

3.1.5.2 Proposed WSTSP Diversion Facilities

Additional diversion facilities have been proposed for development in the general area of the Russian River watershed downstream of Lake Sonoma/WSD to meet future water demands. Diversion facilities may include additional Ranney-type collector wells, conventional wells, infiltration ponds, surface water diversion structures, water treatment facilities, pumps, connecting pipelines, and appurtenances. SCWA is reviewing the types and locations of diversion facilities that may be proposed. Brief descriptions are presented below and should be considered conceptual. It is assumed that the facilities would be located in an area where it would be possible to achieve the required additional water production capacity of 57 mgd for the WSTSP.

Ranney-Type Collector Wells (Collectors)

Collectors would be similar to those previously described for existing diversion facilities. Approximately four to six collectors would be constructed, operated, and maintained. Each collector would consist of a vertical concrete caisson with horizontal perforated intake pipes to collect naturally filtered water from an aquifer associated with Dry Creek or the Russian River. At the top of the caisson would be a pumphouse with electric motors, pumps, and appurtenant controls for operation of the collector. Other appurtenances may include, but would not be limited to: connecting pipelines, access roads, observation wells, electrical equipment, radio telemetry equipment, water treatment (disinfection) equipment, and emergency power generators and associated fuel storage. If production capacity could be achieved via natural recharge to the aquifer, no additional diversion structures or infiltration ponds would be necessary; however, if artificial recharge is necessary, it is likely that additional infiltration ponds or diversion structures would be required. The SCWA system includes three conventional wells at Occidental Road, Sebastopol Road, and Todd Road.

Conventional Wells

Assuming a production capacity of 2 mgd to 3 mgd per each conventional well, approximately 19 to 29 production wells could be constructed, operated, and maintained. Well depths would be approximately 100 feet. Each well would be equipped with submersible or vertical turbine pumps. Other appurtenances may include, but not be limited to: connecting pipelines, access roads, observation wells, electrical equipment, radio telemetry equipment, water treatment (disinfection) equipment, and emergency power generators and associated fuel storage. If production capacity could be achieved via natural recharge to the aquifer, no additional diversion structures or infiltration ponds would be necessary; however, if artificial recharge is necessary, it is likely that additional infiltration ponds or diversion structures would be required.

In 1998 and 1999, the SCWA drilled and developed replacement wells at the Occidental Road and Sebastopol Road well sites to restore the original water production capacity of the wells. The loss in capacity was a result of the Occidental Road well screen having collapsed, and the Sebastopol Road well producing excessive amounts of sand. The two new wells at Occidental and Sebastopol roads and the existing well at Todd Road are cased to depths of 770, 1,040, and 805 feet, respectively. The three wells are capable of producing a combined total of approximately 5 to 7 mgd. In April 1999, at the request of SCWA, CDHS amended SCWA's domestic water supply permit to allow the Todd Road well to be used as an active, rather than standby, source. The Sebastopol Road well was permitted as an active source in 2002.

Chlorine is added to the water produced at each of the three well sites to maintain protective residual levels of chlorine within the system and prevent contamination. In addition, a treatment system has been installed at the Todd Road well, which adds a small dose of an ortho-polyphosphate compound to the well water. The treatment was installed to determine whether it would be effective at eliminating the hydrogen sulfide odor, which frequently occurs in the water produced at all three wells. Although the hydrogen sulfide does not affect the potability of the water, it is a secondary water quality concern, which significantly affects its taste.

Surface Water Diversion and Water Treatment Plant

Additional diversion of surface water directly from Lake Sonoma, Dry Creek, and/or the Russian River would require construction, operation, and maintenance of a water treatment plant. The water treatment plant was not part of the WSTSP.

The treatment process is likely to be a conventional treatment process, Actiflow, or membrane filtration. Conventional treatment processes at the plant may include, but would not be limited to, rapid mixing, coagulation, flocculation-sedimentation, filtration, and disinfection. Facilities associated with the plant may include buildings, access roads, headworks, clarifiers, filters, storage ponds and/or tanks, raw water and finished water pipelines, electrical equipment, radio telemetry equipment, disinfection equipment, and emergency power generators and associated fuel storage. A facility to divert surface water to the treatment plant would also be included. Chemicals used in the treatment and/or disinfection processes may include, but would not be limited to alum, cationic and nonionic polymers, chlorine, and caustic soda.

3.1.5.3 Remaining Transmission Facilities

The Kawana Springs Pipeline and Booster Pump Station were authorized prior to the WSTSP and are currently operational. The Kawana Springs Pipeline connects the Russian River-Cotati Intertie to Kawana Springs Tank No. 1. The Kawana Springs Pipeline consists of approximately 41,700 linear feet (lf) of 36-inch-diameter pipeline, and will serve to meet the demand, storage, and pressure requirements on the transmission system in the south Santa Rosa area. The booster pump station is located in west Santa Rosa, near the intersection of Sebastopol and Wright roads. The locations of the Kawana Springs Pipeline and Booster Pump Station are shown in Figure 2-23.

Construction of Kawana Springs Tank No. 1 has been completed. The tank is located in an unincorporated area of Sonoma County adjacent to the southerly limits of the city of Santa Rosa, approximately 0.75 mile east of the intersection of Kawana Springs Road and Petaluma Hill Road. The tank location is shown in Figure 2-23. The steel tank has a capacity of 10 mg and, once it is in operation, will increase the total storage capacity of the existing transmission system to 118.8 mg.

The Wohler-Forestville Pipeline was also authorized prior to the WSTSP. Construction is expected to begin in early 2004. This pipeline would extend from SCWA's facilities at the Wohler area, generally parallel the existing Forestville Aqueduct for approximately 2.5 miles, and connect with the existing Russian River-Cotati Intertie pipeline near Forestville (Figure 2-23). The pipeline would consist of approximately 12,000 lf of 36- to 60-inch-diameter pipe. The pipeline would connect the 20 mgd of standby capacity provided by Collector No. 6 to the Russian River-Cotati Intertie pipeline.

3.1.5.4 Proposed WSTSP Distribution Facilities

Four major pipelines authorized to meet the future demands on the water transmission system are identified as part of the WSTSP. Pipeline construction will involve the underground installation of approximately 229,000 lf of 18- to 60-inch-diameter, mortarlined and coated, steel pipe and appurtenances. The four proposed pipeline routes will generally parallel existing water transmission pipelines (Figure 2-23). SCWA is in the process of identifying the actual pipeline routes. The following paragraphs describe the four pipelines.

> *Mirabel-Cotati Pipeline*: The Mirabel-Cotati Pipeline would extend from SCWA's facilities in the Mirabel area and generally parallel the existing Russian River-Cotati Intertie pipeline for approximately 14 miles to Cotati. The pipeline would consist of about 72,000 lf of 36- to 54-inch-diameter pipe.

> *Cotati-Kastania Pipeline*: The Cotati-Kastania Pipeline would generally parallel a portion of the existing Petaluma Aqueduct for about 13 miles from the Cotati tanks to the southern end of Petaluma. The pipeline would consist of about 66,000 lf of 24- to 48-inch-diameter pipe.

> *Kawana-Ralphine Pipeline*: The Kawana-Ralphine Pipeline would connect with SCWA's Kawana Springs tanks site at the end of Kawana Springs Road in southeast Santa Rosa and extend approximately 5 miles in a northeasterly direction to connect with SCWA's Ralphine Tanks and the Sonoma Booster Pump Station. The pipeline would consist of about 26,000 lf of 30- to 36-inch-diameter pipe.

> *Annadel-Sonoma Pipeline*: The Annadel-Sonoma Pipeline would generally parallel the existing Sonoma Aqueduct for about 13 miles from the area of Pythian Road to the Sonoma Tanks. The pipeline would consist of about 65,000 lf of 18- to 24-inch-diameter pipeline.

To meet the future demands identified under the WSTSP, an additional 55.5 million gallons of storage is necessary along the transmission system, increasing the existing storage from 118.8 million gallons to 174.3 million gallons. Three to five steel water storage tanks will be constructed, operated, and maintained to provide this additional water storage. Conceptual locations are shown in Figure 2-23. One of these tanks would be a second storage tank at the Kawana Springs location. The proposed site for this tank is adjacent to Kawana Springs Tank No. 1, about 0.75 mile east of the intersection of Kawana Springs Road and Petaluma Hill Road. One to three additional tanks could be located near the existing tanks just west of Cotati, and another tank could be located near the existing Kastania Tank, just south of Petaluma.

Two booster pump stations have been proposed as part of the WSTSP. As with the proposed pipelines, the specific locations of the pump stations are in the process of being identified. Possible locations are shown in Figure 2-23. The booster pump stations are necessary to ensure that the full delivery potential of the expanded transmission system can be achieved. The two proposed booster pumps are conceptually described below.

> *Cotati-Kastania Booster Pump Station*: This booster pump station would be located along the Cotati-Kastania Pipeline. The pump size would be

between 500 and 1,500 hp, and the size of the electrical substation would be between 500 and 1,700 KW. Storage for approximately 25,000 gallons of diesel fuel would be needed.

Sonoma Booster Pump Station Modification (Station No. 2, Pumps No. 2 and 3): This booster pump station would be a modification of the existing Sonoma Booster Pump Station No. 2, located near Spring Lake Park in east Santa Rosa. Two pumps, each approximately 250 hp, would be installed, and modifications to the existing electrical substation would be necessary to increase power by 500 KW. Existing diesel fuel storage at the site would be increased by 15,000 gallons.

3.1.5.5 Previously Authorized Treatment Facilities

Prior to the WSTSP, the construction of an "early warning system" to alert SCWA to the presence of contaminants in the Russian River had been authorized. Because of ongoing operation problems at the three completed stations, the use of living organisms to detect contaminants is no longer being considered.

In October 1998, SCWA tested a water quality monitoring probe at the Mirabel diversion structure for approximately one month. The water quality probe performed well and demonstrated the performance desired by SCWA. SCWA will use the probe to monitor for DO, pH, temperature, turbidity, depth, and conductivity. The probe will not directly detect toxic materials; however, a spill in the river would be expected to alter at least one of the parameters being monitored. If an anomaly is detected, samples will be collected and sent to a laboratory for analysis. Due to the changing parameters of the project, SCWA is referring to the project as the "River Monitoring Stations Project" rather than the "Early Warning Station Project."

The River Monitoring Stations Project includes five river monitoring stations. SCWA has constructed five stations at four USGS gaging stations (located at Hopland, Healdsburg, Hacienda, and Guerneville), and one at the Mirabel diversion structure.

3.1.5.6 Proposed Treatment Facilities

As previously discussed, additional treatment facilities may be needed as part of the expansion of the transmission system to meet future demands. However, the specific type of facilities needed will depend on the type and location of diversion facilities that are ultimately selected.

3.2 WATER MANAGEMENT

Management of instream flow in the Russian River system consists of two primary activities: winter flood control operations, and summer water supply releases. Winter flood control operations are described in Section 3.1. Summer releases are presently regulated by the D1610 instream flow requirements and water supply demands.

Under D1610, flows in the Russian River and Dry Creek must be augmented with releases from storage during the summer months. *Interim Report 3* reported that the augmented flows resulted in velocities that exceeded the velocities in optimal rearing habitat (ENTRIX, Inc. 2002a). The intent of the proposed changes in instream flow management is to use the reservoirs and project facilities conjunctively to improve conditions for listed salmonids. Water releases from CVD will be coordinated with water releases from WSD with the goals of: (1) meeting water supply needs, (2) improving rearing conditions for listed salmonids in the mainstem Russian River and in Dry Creek, and (3) reducing inflow into the Estuary to preclude the need to artificially breach the sandbar between June and September, allowing the Estuary to be operated as a closed system.

3.2.1 Monitoring Studies

Studies have been conducted recently to assess habitat for listed fish species. A flow-related habitat assessment in the fall of 2001 evaluated habitat for juveniles and fry in the mainstem Russian River and Dry Creek at alternative flow scenarios. Flow-related spawning habitat for steelhead and Chinook salmon in the Russian River mainstem was also evaluated. (ENTRIX, Inc. 2002b).

A steelhead distribution and relative abundance study was conducted in the Russian River mainstem in 2002 (See Section 2.2) (Cook 2003). A Chinook salmon spawning survey was conducted in the mainstem in the fall of 2002 (See Figure 2-4) (SCWA, unpublished data).

3.2.2 Water Demand and Supply

SCWA would continue to divert, store, release, and redivert water within the Russian River basin under the terms of SCWA's appropriative water rights permits to meet present and future water demand as described in Section 2.5. SCWA is currently authorized to divert and redivert a total of up to 75,000 AFY from the Russian River, at a maximum rate of 180 cfs. The WSTSP (see Section 2.5) would provide a safe, economical, and reliable water supply to meet future needs in the SCWA service area. The WSTSP would:

- implement water conservation measures that would result in the savings of approximately 6,600 AFY (see Section 3.5.3), and expand the water education program;
- increase the amount of water diverted from the Russian River (a combination of rediversion of stored water and direct diversion of winter flow) by 26,000 AFY, thereby increasing the total amount of diversion from 75,000 AFY to approximately 101,000 AFY; and,
- increase the transmission system capacity by 57 mgd, thereby increasing the total capacity of the transmission system from 92 mgd to 149 mgd.

3.2.3 FLOW PROPOSAL

Under current D1610 operations, summer flow levels result in velocities that are too high for rearing salmonids (see Section 2.5 and ENTRIX, Inc. 2002a). Additionally, the cold water pool in Lake Mendocino is depleted prior to the end of the summer rearing period, which could result in stressful temperatures in the upper and middle Russian River for juvenile steelhead in the late summer. High summer flow into the Estuary creates the need for artificial breaching in the summer period. The proposed flow regime addresses these concerns. Specific objectives of the proposed flow modifications are to:

- Reduce summer velocities in Dry Creek and the upper Russian River.
- Conserve the cold water pool in Lake Mendocino through the late summer.
- Enable SCWA to meet existing water rights in the Russian River and Dry Creek.
- Enable SCWA to meet future demand as contemplated in the WSTSP.
- Allow the sandbar at the mouth of the Russian River to be closed in the summer.

This section describes a flow proposal under consideration for implementation. An implementation plan and proposed permit terms are included in Appendix A for the proposed flow regime. SCWA is conducting additional evaluations of the flow proposal and potential effects associated with its implementation.

Winter flows in the Russian River and Dry Creek are the result of natural runoff from unregulated streams and flood control operations at CVD and WSD. This flow proposal would not substantially alter winter flow management. Summer flows would be lower in the Russian River Dry Creek, as would summer inflow to the Estuary. The proposed Estuary management is discussed in Section 3.3. The following discussion of the flow proposal focuses on summer (July to October) conditions. Flows are summarized for two cases: *all* water supply conditions, which combines the *normal*, *dry*, *dry spring*, and *critically dry* as defined by D1610; and *dry* water supply conditions, which describes the flows that occur during *dry* water supply conditions as defined by D1610. (Water supply conditions are defined in Section 2.5.)

3.2.3.1 Russian River between East Fork and Dry Creek Confluence

Flow releases to the Russian River between the East Fork and Dry Creek (upper and middle Russian River) would be managed for flows to meet SCWA’s water demands at Wohler and Mirabel, water demands that are senior to SCWA’s, provide suitable conditions for rearing salmonids during the summer months in the Russian River, and provide optimal Estuary inflow in conjunction with WSD releases and Wohler and Mirabel operations. This would be accomplished in coordination with the flow releases from WSD. Minimum flow requirements established at Healdsburg would range from 50 to 150 cfs during *normal*, *dry*, and *dry spring* water supply conditions for the portion of the river between the Forks and Dry Creek, with a minimum flow in the East Fork of 25 cfs at all times (Table 3-2). An exception to the *normal* flow requirements would occur if, anytime between November 1 through December 31, storage in Lake Mendocino fell below 30,000 acre-feet, the required minimum flow rate would be reduced from 150 cfs to 75 cfs. During *critical* and *critically dry* water supply conditions, minimum required flows in the upper and middle Russian River would be reduced to 25 cfs. Summer flows in the upper and middle Russian River would usually exceed the minimum flows in order to meet all water supply needs.

Table 3-2 Minimum Streamflow Requirements (cfs) for the Upper and Middle Russian River

	Month											
Water Supply Condition	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Normal	150	150	150	100	100	50	50	50	50	50	150/75[1]	150/75[1]
Dry	75	75	75	75	75	50	50	50	50	50	75	75
Critically Dry	25	25	25	25	25	25	25	25	25	25	25	25
Dry Spring	150	150	150	100	100	50	50	50	50	50	75	75
East Fork	25	25	25	25	25	25	25	25	25	25	25	25

[1]75 cfs when storage in Lake Mendocino is less than 30,000 AF.

3.2.3.2 Russian River below Mirabel Inflatable Dam

Flows in the Russian River below the Mirabel Dam would be managed to avoid the need to breach the sandbar at the mouth of the Russian River during the summer. Minimum flows at the Hacienda gage would be the greater of 35 cfs or the "natural flow."

The "natural flow" of the lower Russian River is intended to mimic what the flow in the lower river would be under predevelopment conditions. The implementation plan in Appendix A describes the process for determining the "natural flow". This flow scenario uses flows in Austin Creek or Maacama Creek (both streams are relatively unaffected by development) to predict what the natural flow would be in the Russian River. The natural flow of the Russian River at Hacienda Bridge is defined as 11.77 times the four-day running average of the gaged flow of Austin Creek (USGS Gage No. 11467200). During periods in which that gage is malfunctioning or otherwise not available, the natural flow is defined as 24.89 times the four-day running average of the gaged flow in Maacama Creek at the USGS gaging station near Kellogg, California. Generally, natural flow would be the minimum flow during the summer months, but the minimum flow would never be less than 35 cfs. Releases from storage would be made to maintain this flow until flows increase above a specified "transition flow" after which no additional water would be released from storage to maintain the "natural flow". The transition flow describes when natural runoff becomes the dominant factor determining flows and project operations are less important (Table 3-3). When the "natural flow" in the lower Russian River exceeds the transition flow rate, the required minimum instream flow would be the transition flow.

When the Estuary closes (typically between July and October), the minimum flows at Hacienda Bridge would be the lesser of the natural flow or the Optimal Estuary Inflow. The Optimal Estuary Inflow rate is the rate that would maintain the water surface elevation (WSE) at the Jenner gage at 7.0 feet. It is currently estimated that the inflow to the Estuary that will maintain a stable WSE at this level is about 90 cfs. This level will avoid the local flooding that requires the Estuary to be breached periodically under current operations, and will allow the Estuary to remain closed. A closed system is expected to improve rearing habitat for salmonids in the lower part of the river.

Table 3-3 Lower Russian River Transition Flow Rates (cfs)

	Month											
Water Supply Condition	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Normal	125	125	125	150	150	125	125	125	125	125	125	125
Dry	125	125	125	150	150	125	125	125	125	125	125	125
Critically Dry	35	35	35	35	35	35	35	35	35	125	125	125

3.2.3.3 Dry Creek

The minimum flow rates required under D1610 in Dry Creek would be modified so that the optimum range of flows for rearing coho salmon, steelhead, and Chinook salmon would normally be provided (Table 3-4). The optimum range of flows for rearing habitat is 30 to 70 cfs for steelhead fry and 30 to 90 cfs for coho salmon fry (ENTRIX, Inc. 2002a).

Table 3-4 Minimum Streamflow Requirements (cfs) for Dry Creek

	Month											
Water Supply Condition	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Normal	90	90	90	50	50	25	25	25	25	25	90	90
Dry	75	75	75	50	50	25	25	25	25	25	75	75
Critically Dry	75	75	75	50	50	25	25	25	25	25	75	75

Under the flow proposal, the flow requirements for Dry Creek would be modified so that under *normal* water supply conditions, flows during May through October would be managed at the mouth to provide suitable rearing flows. The flow proposal strives to provide the operational flexibility to meet short-term water demand at Mirabel and to adaptively manage the inflow to the Estuary. At buildout, summer releases from Lake Sonoma in excess of 90 cfs would be expected only during *critically dry* water supply conditions (about 2 percent of the summer period). Releases from Lake Sonoma of this magnitude would be required to ensure that Lake Mendocino does not become dewatered. During *critically dry* water supply conditions, releases from Lake Mendocino would be reduced, and releases from Lake Sonoma would be increased to meet water demands at Mirabel. Minimum flow requirements in Dry Creek would range from 25 cfs in the summer months to 90 cfs in November and December.

3.2.3.4 Modeling of the Proposed Flow Regime

In the discussion that follows, the flow conditions that will occur under the proposed flow regime in the different reaches of the Russian River (upper, middle, and lower) and Dry Creek are represented by simulations conducted with the RRSM. These simulations are based on the same hydrologic and meteorologic conditions used in describing the flow conditions under D1610. Specifically, the simulations include a 90-year simulation from 1910 to 2000. The flow regimes described include two water demand scenarios. The existing demand scenario reflects the current level of water supply demand. The future demand scenario reflects the water supply demand conditions that would occur at full buildout, as described by the WSTSP. As with D1610, the RRSM model nodes used to describe flow conditions within the basin are Ukiah for the upper Russian River, Cloverdale and Healdsburg for the middle Russian River, Hacienda Bridge for the lower Russian River, and below WSD and at the mouth for Dry Creek.

Existing Demands

Under the proposed flow regime, median flows in the upper Russian River near Ukiah between June and October would range from about 108 to 195 cfs when *all* water supply conditions are considered (Table 3-5). These flows are generally highly suitable for young steelhead (Chinook are not present after July, and coho do not rear in the mainstem). When only *dry* year water supply conditions are considered, median flows would be slightly higher from June through October (109 to 205 cfs), with reductions in October.

At Cloverdale, median flows would range from 94 to 185 cfs in June through October when *all* water supply conditions are considered. Flows are similar when only *dry* water supply conditions are considered. At Healdsburg, median flows would range from 90 to 183 cfs during this period for *all* water supply conditions, with slower flows under *dry* water supply conditions.

During the June through October under existing water supply demands, median flows at Hacienda would range from 166 cfs in June to 49 cfs in September when *all* water supply conditions are considered. Under *dry* water supply conditions, median flows would range from 105 cfs in June to 44 cfs in September.

Typically, flows in Dry Creek would be similar to what they are under baseline operations from November through May. From June through October, median flows would range from about 41 to 71 cfs immediately below WSD. Under *dry* water supply conditions, summer flows would be similar to those for *all* water supply conditions. Median flows at the mouth of Dry Creek would range from 35 to 65 cfs under both *all* and *dry* water supply conditions.

Table 3-5 Expected Ranges of Summer (July through October) Median Flows in the Russian River and Dry Creek under Existing Water Demands for the Proposed Flow Regime

All Water Supply Conditions					
Stations	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Ukiah	187	195	135	108	182
Cloverdale	183	171	111	94	185
Healdsburg	187	151	102	90	183
Russian River below Dry Creek	216	180	161	150	218
Hacienda Bridge	166	84	50	49	136
Dry Creek at Warm Springs Dam	41	47	71	63	35
Dry Creek above Russian River	34	34	65	61	32
Dry Water Supply Conditions					
Stations	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Ukiah	205	218	126	109	95
Cloverdale	187	181	107	92	93
Healdsburg	150	136	101	86	93
Russian River below Dry Creek	192	171	157	147	140
Hacienda Bridge	105	56	46	44	48
Dry Creek at Warm Springs Dam	48	52	68	66	49
Dry Creek above Russian River	38	39	62	64	50

Future Demands

To maintain the improved habitat conditions that this flow proposal would create for salmonids as water supply demand increases in the future, SCWA will develop and implement one or more additional measures to allow flows to remain near the levels described above. These additional measures are described in 3.2.2.5. Without these additional measures, higher releases would be required from CVD and WSD, resulting in flows the Upper Russian River and Dry Creek that would approach those that currently occur under D1610. Flows in the Russian River and Dry Creek were modeled assuming that any necessary additional measures would be implemented to maintain suitable rearing flows under future water demands.

During June through October, median flows in the upper Russian River near Ukiah would range from about 164 to 217 cfs when *all* water supply conditions are considered. Under *dry* water supply conditions, median flows would range from 172 to 270 cfs.

At Cloverdale, median flows would range from 149 to 211 cfs in June through October when *all* water supply conditions are considered. Under *dry* water supply conditions, median flows would range from 151 to 223 cfs.

At Healdsburg, median flows would range from 143 to 211 during this period when *all* water supply conditions are considered and from 141 to 184 cfs under *dry* water supply conditions. These flows would be similar to those under the current demand scenario.

Flows in these ranges would provide highly suitable rearing habitat for a majority of the time under higher future demands.

During June through October, median flows in the lower Russian River at Hacienda would range from about 50 to 172 cfs when *all* water supply conditions are considered. Under *dry* water supply conditions, median flows would range from 45 to 119 cfs.

From June through October under future demands, median flows immediately below WSD would range from about 49 to 60 cfs under *all* water supply conditions. Under *dry* water supply conditions, summer median flows would range from 57 to 80cfs. Flows during this period at the mouth would be slightly lower, ranging from 174 to 244 cfs under *all* water supply conditions, and 172 to 226 cfs under *dry* water supply conditions.

3.2.3.5 Summary of Proposed Flows

The flow proposal is designed to meet water supply needs, to improve summer rearing habitat in the upper Russian River, Dry Creek, and the Estuary, and to allow the mouth of the river to close, thereby providing more consistent estuarine rearing conditions. Under the flow proposal, summer flows would be lower than those under baseline conditions. Median flows expected under the flow proposal during the summer months are expected to be similar under both the existing and future water supply demands due to implementation of additional measures.

Expected ranges of summer median flows in the Russian River and Dry Creek under existing demands for the flow proposal are given in Table 3-5.

Existing Demands

Under baseline conditions, median summer flows at Ukiah are typically 167 to 231 cfs (see Section 2.5). Under the proposed project, flows at Ukiah are expected to range from approximately 108 to 195 cfs under current water supply demands. Near Cloverdale, the median monthly flows would range from 94 to 185 cfs. Near Healdsburg, flows are anticipated to range from 90 to 187 cfs.

Under this flow proposal, flows in the Russian River downstream of the Mirabel inflatable dam would avoid the need to artificially breach the sandbar across the river mouth. At Hacienda, the median monthly flows in the summer would range from approximately 50 to 166 cfs under current water supply demands.

Below WSD, median monthly flows would range from approximately 35 to 71 cfs under current water supply demands. Flows at the mouth of Dry Creek would be slightly lower. However, flow releases during *dry* years are expected to be higher and may reach 200 cfs for short periods. Under *critically dry* water supply condition, flows in Dry Creek would remain high for longer periods of time.

Future Demands

To maintain the improved conditions that this flow proposal would create for salmonids as water supply demands increase in the future, SCWA will develop and implement one or more additional measures to allow flows to remain near the levels described above. The primary measures being considered are: an aquifer storage and recovery (ASR) program; a pipeline from WSD to the mouth of Dry Creek, the Wohler diversion facility, or a treatment plant; and additional storage facilities (see following section).

Under this flow proposal, flows in the middle and upper Russian River are anticipated to remain stable over time as water supply demand increases. Median flows in Dry Creek are anticipated to increase slightly under the future demand scenario (relative to existing demand), but would remain within the range of suitable flows for salmonid rearing. Flows at Hacienda are expected to be similar to those under existing demands in the summer months. It is anticipated that the Estuary could be managed as a closed system from July through October under both current and future water supply demands.

The flow proposal is designed to meet water supply needs, to improve summer rearing habitat in the upper Russian River and Dry Creek, and to allow the mouth of the river to close, thereby providing more consistent estuarine rearing conditions. Under the flow proposal, summer flows would be lower than those under baseline conditions; under baseline conditions, median flows at Ukiah are typically 167 to 231 cfs (see Section 2.5). Median flows expected under the flow proposal during the summer months are expected to be similar under both the existing and future demand scenarios. Flows in the upper and middle Russian River are expected to be similar under *dry* water supply conditions and *all* water supply conditions under either demand scenario. Flows at Hacienda (lower Russian River) would be lower under *dry* conditions than under *all* conditions. Median flows in Dry Creek would increase somewhat under the future demand scenario (relative to existing demand), but would remain within the range of suitable flows for salmonid rearing.

Under this flow proposal, flows in the middle and upper Russian River are anticipated to remain stable over time as water supply demand increases. Flows in Dry Creek are anticipated to increase somewhat in some months. Flows at Hacienda are expected to be higher in June under the projected future demand scenario than under the existing demand scenario; flows are similar in the remaining summer months. An integral feature of this flow regime is modifications to Estuary management practices. The Estuary would be managed as a closed system from July through October under both the current and future demand scenarios.

3.2.3.6 Additional Measures

To maintain suitable rearing habitat for young salmonids as water demand increases in the future, SCWA would develop additional measures to meet the additional demand. These measures would not require additional water to be released to the upper Russian River or Dry Creek. The primary physical solutions being considered are:

- an aquifer storage and recovery (ASR) program
- a pipeline from WSD to the mouth of Dry Creek, the Wohler diversion facility, or a treatment plant
- other storage facilities to be developed by SCWA

SCWA may develop and implement a combination of these options or others, in a phased manner as demand increases. While these measures are unnecessary under the existing supply demands, they will likely be necessary in the future. Future studies will need to be conducted to evaluate the feasibility of these concepts. The ASR and pipeline options are described below.

Aquifer Storage and Recovery

ASR is a method of water resource management utilized throughout the U.S. and the world that uses surface water supplies conjunctively with groundwater resources. For example, ASR is a water resource management strategy proposed by CALFED Bay-Delta Authority. Conceptually, an ASR strategy would involve pumping water from SCWA's diversion facilities at the Russian River through the transmission system to groundwater recharge facilities in areas such as the Sonoma Valley, Santa Rosa Plain, or Petaluma Valley. This program would coordinate the timing of diversions from the Russian River to more closely match natural flow conditions. For example, relative to current practices, diversion of Russian River water would be increased when flows are naturally high in the winter and spring and reduced during the summer months when river flows are naturally low. Water diverted during the non-peak season would be stored in aquifers that are not contiguous with the Russian River. Water would be extracted from the storage in these off-river aquifers during the peak-demand season, thereby reducing the amount of water that would be diverted from the Russian River during periods of peak demand. This method of operation would allow lower flows to be maintained in Dry Creek and the upper Russian River during the summer.

Water would be diverted from the Russian River for aquifer storage from November through May. Existing diversions from the Russian River would continue up to the allowable annual limits in SCWA's existing water rights permits. However, the timing of diversions would be modified as described above relative to current operations.

Diversion facilities may include Ranney-type collector wells, conventional wells, infiltration ponds, diversion structures, water treatment facilities, pumps, connecting pipelines, and related appurtenances.

ASR would improve operational flexibility and reliability as it would increase the diversity of supply sources available to meet demand and distribute these sources of water throughout Sonoma County. These supplies could be brought on-line quickly to meet peak demands. The increased diversity of supply sources would also provide greater reliability in the event of some catastrophic event that might impair the ability to divert and transport water from the Russian River. ASR would also likely reduce the number of diversion facilities along the Russian River that would need to be constructed to meet future water supply demands. The ASR concept would be studied further to determine its feasibility.

Pipeline

Another physical solution to reducing flows in the Russian River and Dry Creek is to construct a pipeline from WSD. This pipeline could terminate either at the mouth of Dry Creek, the Mirabel facilities, or at a treatment plant at a site to be determined. A new pipeline would likely be installed in the dam's wet well or outlet structure of WSD, or may require construction of a new outlet structure. The pipeline would require obtaining rights of way along Dry Creek and the Russian River. Releases from WSD to Dry Creek would remain in the range described for the existing water supply demand scenario. Any additional flow needed to meet water supply needs would be conveyed through the pipeline.

3.3 ESTUARY MANAGEMENT

The objective of the proposed Estuary management is to eliminate infrequent artificial breaching of the sandbar during the summer months. Artificial breaching may be required in the spring or fall, and in some dry winters to manage storm flow input to the Estuary.

Under the proposed action, the Estuary would be managed with the goal of maintaining a closed system with freshwater habitat during the low-flow (summer) season. This action is expected to reduce the frequency, duration, and intensity of poor water quality events. The freshwater system is expected to provide additional rearing habitat for young steelhead in a lagoon environment. Under the flow proposal, flow to the Estuary would be low enough to avoid artificial breaching in the summer.

Under D1610, the Estuary cannot be managed as a closed system during *normal* water supply conditions because required minimum flows at Hacienda are too high. Therefore, the proposed Estuary management action is an integral component of the flow proposal and could only be implemented in concert with the flow proposal. Implementation of the flow proposal allows dry season inflow to the Estuary to be substantially lower than permitted under D1610.

The Estuary has been managed by artificial breaching for decades. Because there is uncertainty regarding the ability to manage the Estuary as a closed or lagoon system, additional studies would be implemented to gain a greater understanding of the effects of water quality on salmonid habitat and the feasibility of flow management to avoid breaching. During the first five years of implementation of this management action, a monitoring program would be conducted to determine if the management program is achieving improved rearing conditions. The monitoring program would be implemented when the flow proposal is implemented and the management of a closed Estuary begins. The monitoring program would extend through the five-year period and would assess the relationship between flow and WSE in the Estuary and water quality. Estuary management may be modified based on the information collected during the first five years of implementation of the proposed action to maintain suitable habitat for salmonids.

If, for a given year, summer flows (exclusive of project-controlled flows) were too high to manage the Estuary as a closed system, an alternative management practice would be implemented with more frequent breaching to maintain water quality (e.g. late or early storms that increase flow in the river). Under the flow proposal, dry season flows allow the Estuary to be managed as a closed system.

3.3.1 LOW-FLOW ESTUARY MANAGEMENT

Once the sandbar forms across the river mouth, flow in the Russian River to the Estuary would be managed to maintain a target WSE of 7.0 feet or less as recorded on the Jenner gage. This would eliminate the need to artificially breach the sandbar that forms across the river mouth during the dry season. If dry season inflow were low enough that the WSE can be maintained at the target level, no artificial breaching during the low-flow season would occur. Under this scenario, the system would be managed as a lagoon (sandbar closed).

The target WSE of 7.0 feet may be expected to vary as much as 1 foot (between 6.0 and 8.0 feet at the Jenner gage). Based on an analysis of the relationship between flow at the Hacienda gage and stage change at Jenner, a preliminary estimate of the flow needed to maintain a constant WSE of 7.0 in the lagoon is 90 cfs or less.

Releases to the lower river downstream of the Mirabel diversion facilities would be managed under a range of river and ocean conditions. Actual flow rates in the Russian River (at Hacienda Bridge) during the spring-summer transition will track the natural flow, as determined from the surrogate stream, Austin Creek or Maacama Creek. The Estuary WSE that will result from these flow rates will vary from 8.0 feet to less than 7.0 feet.

3.3.2 ALTERNATE LOW-FLOW ESTUARY MANAGEMENT

If, for a given year, the Estuary could not be managed as a closed system due to high flows, alternative management practices (sandbar open) would be implemented. The objective of this action is to maximize water quality for salmonids by eliminating infrequent dry season breaching. When the sandbar is open, water quality would be maintained by tidal flushing. When dry season flows to the Estuary (exclusive of project-controlled flows) are high enough that the WSE at the Jenner gage would regularly exceed 9.5 feet and it becomes necessary to breach the sandbar, a program of frequent artificial breaching would be implemented. This would limit the amount of time that the sandbar remains closed to no longer than seven days. The Estuary would be kept open to tidal mixing throughout the remainder of the dry season. Breaching would follow the protocols discussed below.

An exception to this program of frequent breaching may be made during the first five years that the lagoon plan is managed as a closed system to take advantage of opportunities to collect information during the monitoring program.

3.3.3 Storm Flow Estuary Management

Artificial breaching of the sandbar across the mouth of the Russian River would still be required to manage storm flow and prevent flooding to private property and roads. Artificial breaching has historically occurred before WSE at the Jenner gage reaches 7 feet. Inundation of property begins at a WSE of approximately 10 feet, but the sandbar closing the mouth can reach elevations above 15 feet (RREITF 1994). Repeated breaching may be necessary if inflow is insufficient to maintain an open mouth but high enough to cause flooding. In dry winters, regular breaching may be necessary during the rainy season. Two basic categories of breaching events are defined, based on their potential to affect water quality in the Estuary or in a lagoon: early season breach events and late season breach events.

3.3.3.1 Timing of Artificial Breaching

The timing of natural sandbar breaching is variable and depends on local weather patterns, ocean conditions, runoff from the Russian River basin, and inflow to the lagoon.

Early Season Breach Events

Early season artificial breach events occur at the onset of the fall rainy season. Artificial breaching would be conducted as close as is practical to the time that a natural breach might occur, but would be implemented before WSE exceeds 9.5 feet.

Artificial breaching would be undertaken when an imminent threat of flooding exists. Artificial breaching will occur when flows at the Hacienda gage exceed 1,100 to 1,200 cfs or when the WSE of the lagoon, as recorded at the Jenner gage, is rising at a rate that indicates it will reach the 10-foot flooding elevation within 48 hours. The timing of the breaching activity would be conducted earlier if work conditions pose safety risks to crews. The objective of this protocol is to time the artificial breaching as closely as possible to when natural breaching would occur without undue risk to personnel or equipment.

Late Season Breach Events

Late season breach events are defined as events that occur near the end or after the end of the rainy season. Because late season breaching during low-flow periods can be an important factor in summer water quality conditions, they will be minimized to the extent that is practical. Late season breaches will only be conducted if runoff from a rainfall event is likely to result in WSE greater than 9.5 feet.

The target WSE of approximately 7.0 feet at the Jenner gage when the sandbar is closed would provide sufficient inflow for rapid conversion to freshwater conditions. As water loss from the lagoon is likely to vary, a five-year period will be needed to learn the optimum protocols over a range of environmental conditions.

3.3.3.2 Staging Area and Access to Site

Heavy equipment for breaching would be restricted to the beach area and staging would take place in the Goat Rock parking lot away from water. The equipment would be brought from the parking lot and driven to the breaching area. The sandbar would be breached north of the jetty, at least 150 feet from the oceanside point of the jetty. No special protocols will be implemented because no vegetation or other sensitive resources occur between the staging and work areas.

3.3.3.3 Equipment and Methods

Following the decision to breach, two full days are required to mobilize equipment and issue notifications. Sandbar breaching can take from 1 to 10 hours. Initial breaching of the sandbar will normally be completed using a bulldozer. A channel would first be dug between the ocean and the berm of the sandbar, leaving a sand berm between the breaching channel and lagoon. This berm would extend the width of the excavated channel and be wide enough to retain water within the lagoon. The berm will remain in place until overtopped and broken naturally by high tides or rising water levels in the lagoon. The shortest distance between the lagoon and the ocean would be selected as the breach path so that minimum amounts of sand would need to be moved. A bulldozer would shape a swath approximately 20 feet in width and 2 feet in depth by pushing sand to the north and south of the breach area until the bottom of the channel is level with the lagoon WSE. A bulldozer then would cut a pilot channel with a final pass from east to west from the lagoon to the ocean.

The erosive force of the water that runs through the pilot channel will widen and deepen the channel, creating a large outflow channel across the beach within a few hours. By the time water has drained from the Estuary, the channel is expected to be about 100 feet wide. Because inflow can exceed initial breaching outflow, the lagoon may continue to rise after initial breaching and it may take a number of hours before the outflow balances with the inflow.

The excavated sand would be placed on the beach. This sand will be reworked by the surf during the next few days. In the winter, steep, high-frequency waves tend to move sand from the beach to an offshore bar. In the summer, the waves are smaller and farther apart, and move the sand from the sandbar back to the beach.

Subsequent breaching, if required during the rainy season, may require less effort and may be completed with hand shovels.

Breaching will occur under the following conditions:

1. When the tide has peaked and is receding. This will allow sufficient time for the river flow to widen and deepen the newly cut channel so that the lagoon will stay open during the next high tide.

2. Work will be conducted in daylight hours when possible. Large waves can sweep up on the bar, especially at high tide. Therefore, the work will be done during daylight hours when workers can see large waves.

SCWA crews would post signs 24 hours prior to breaching the sandbar and remove the signs 24 hours after breaching is complete.

3.4 CHANNEL MAINTENANCE

SCWA would continue to conduct channel maintenance activities in the Russian River and its tributaries to reduce the potential for flooding and erosion. SCWA's actions include activities related to flood control and bank erosion control in the Mark West Creek watershed, flood control activities in the Central Sonoma Watershed Project, activities related to CVD and WSD, activities related to streambank erosion control in the Russian River, and emergency actions in natural channels.

Sediment maintenance, channel debris clearing, vegetation maintenance, and bank stabilization are some of the proposed activities. Others include top-of-bank landscape and structure maintenance, and storm drain outfall maintenance. An overview of baseline conditions and practices in these categories is provided in Section 2.7. The proposed modifications to channel maintenance activities are described in this section.

Channel maintenance activities would include:

1. Channel maintenance within the Central Sonoma Watershed Project and Mark West Creek watershed.

2. Russian River

   i) Channel maintenance related to the construction and operation of CVD.

   ii) Channel maintenance related to USACE-identified and -constructed flood and erosion control sites (federal sites).

   iii) Channel maintenance related to Public Law 84-99 sites (non-federal sites).

   iv) Debris removal as necessary to protect life and property.

3. Dry Creek channel maintenance related to the construction and operation of WSD (federal sites and one Public Law 84-99 nonfederal levee).

4. NPDES storm water discharge permit activities.

SCWA channel maintenance would be conducted as a cooperative effort between SCWA operation and maintenance staff and biologists to achieve both flood control and aquatic and riparian habitat objectives. Channel maintenance would be conducted in accordance with RWQCB WDR 81-73. For all of the activities described below, SCWA would comply with the BMPs described in the San Francisco Bay Area Stormwater Management Agencies Association's *Flood Control Facility Maintenance Best*

Management Practices - A Manual for Minimizing Environmental Impacts from Stream and Channel Maintenance Activities.

MCRRFCD would continue to conduct channel maintenance activities related to the CVDP in Mendocino County. This includes maintenance of federal sites and inspections of Public Law 84-99 sites. MCRRFCD would also conduct activities related to streambank stabilization in the mainstem of the Russian River.

SCWA would also perform channel maintenance activities on channels in the Russian River watershed that have undergone restoration activities. For example, SCWA has entered into an agreement with the City of Santa Rosa regarding maintenance of portions of Santa Rosa Creek upon completion of the City of Santa Rosa's Prince Memorial Greenway project.

SCWA would perform channel maintenance activities for certain natural channels, constructed flood control channels, and for certain flood control channels that have been modified to provide increased habitat value for fish and wildlife species. The following sections describe channel maintenance activities for sediment maintenance, channel debris clearing, vegetation maintenance, and bank stabilization. Channel maintenance activities in constructed flood control channels differ from those in natural waterways, and are discussed separately. In addition, channel maintenance activities in Dry Creek and the Russian River are discussed separately from other activities in natural waterways.

Infiltration capacity at the Wohler and Mirabel diversion facilities would be augmented by periodically recontouring gravel bars in the Russian River upstream of the inflatable dam and downstream of the inflatable dam near the Mirabel and Wohler infiltration ponds.

3.4.1 Sediment Removal and Channel Debris Clearing

Sediment buildup in flood control channels can reduce the capacity of the channels and reduce the level of flood protection. Sediment removal and vegetation removal activities are necessary to maintain channel capacity and control streambank erosion. SCWA would continue to conduct channel maintenance activities on more than 300 miles of streams within Sonoma County, most of which are located in the Russian River watershed, including both constructed flood control channels and natural waterways (Tables 2-20 and 2-22, respectively). Sediment removal would be done as-needed in constructed flood control channels. Occasionally, emergency sediment and debris removal would be conducted on natural waterways in response to an event such as a large storm, as defined under USACE nationwide permits.

3.4.1.1 Constructed Flood Control Channels

Sediment removal and vegetation maintenance would be conducted to maintain flood capacity of constructed flood control channels. Excessive sediments tend to be deposited at locations where the channel gradient significantly decreases, such as along Hinebaugh and Copeland creeks, and as the channel traverses from the steep gradient headwaters on

Sonoma Mountain to the low-gradient valley plain in Cotati and Rohnert Park. Sediment removal would be conducted on an as-needed basis.

Streams would be scheduled for sediment removal when field inspections indicate that the invert elevation of outfall structures is generally less than 12 inches above the streambed elevation. Sediment removal would be performed during summer or fall months (until October 31). Only segments of the channel reach that inspections determine have become hydraulically impaired would have sediment removed. Sediment removal would consist of excavation of bars that have accumulated bed material and become enlarged by deposition over time.

The bars tend to create a meandering, sinuous pattern along the low-flow channel bottom. The bars effectively create a narrower channel bottom so that the low-flow channel has greater depth for a given flow than without the bar deposits. This improves fish passage for both upstream adult migration and outmigration by juvenile steelhead.

SCWA would evaluate the feasibility of actions that maintain a low-flow channel as part of the sediment removal work, and implement those actions in channels where it has the potential to improve availability of quality habitat without compromising flood control capacity. Channels that require more frequent or aggressive maintenance and that provide access to upstream spawning or rearing habitat will reap maximum biological benefit.

The goal is to maintain some low-flow channel sinuosity that provides better depths for migration following sediment maintenance. One option is to lower the height of the bar deposits by excavation, but leave a portion of the deposit in place above the channel design invert, with a perimeter of buffer vegetation to help stabilize the bar after excavation. This could result in the need for more frequent sediment maintenance activities, but would improve water depths for fish passage.

Another option is to identify channels where it may be appropriate to install a series of vortex weirs. This would be determined on a site-specific basis. Such an action may be effective, particularly in a low-gradient, high-sediment supply channel that is characteristic of channels on the valley floor in Cotati, for example. These weirs would be designed to create backwater areas at low flows, thereby improving fish passage.

3.4.1.2 Natural Waterways

SCWA would not perform routine sediment removal activities in natural waterways. SCWA has hydraulic maintenance easements that are permissive and SCWA would continue to access various natural creeks to remove debris or vegetation to restore hydraulic capacity (Table 2-22).

Occasionally, emergency sediment and debris removal would be conducted on natural channels, including the Russian River. This would usually occur in response to an event such as a large storm that produces situations where channel flood capacity is diminished and streambanks are threatened or damaged (discussed in Section 3.4.2).

3.4.1.3 Flood Control Reservoirs

SCWA flood control reservoirs would continue to be operated as described in Section 2.7.

Sediment would be removed as needed in the flood control reservoirs maintained by SCWA, i.e., Spring Lake, Brush Creek (rarely needed), Paulin Creek (every 15 years), Matanzas Creek (approximately every ten years), and Spring Creek diversion facility (approximately every 10 years). Sediment excavation would be performed either when the reservoir is dry, or when there is no flow out from the reservoir. Matanzas, Spring Lake, and Piner reservoirs would be drained before sediment removal activities. The frequency of this maintenance would vary, depending on the reservoir and the level of sediment that has accumulated, but could be from every three years to ten years. Sediment removed from the flood control reservoirs would be trucked to an off-site disposal area. Vegetation removal at the outfall of the reservoirs could occur annually, if needed.

When Spring Lake is drained for maintenance work, it would be drained as early as possible in the spring before lake waters become very warm, to avoid increasing water temperatures in Santa Rosa Creek (the recipient of water from Spring Lake). This work would be performed every 15 years.

3.4.1.4 Sediment Maintenance and Channel Debris Clearing Practices

Sediment removal would be conducted with excavators with extended arms, and in some areas, with bulldozers as well. Excavating equipment with a reach ranging from 21 to 41 feet would be used, depending on the channel being cleared. The equipment would be driven along the access road and sediment removal would be done perpendicular to the channel length. Bulldozers would be used in high width/depth ratio channels where excavators cannot reach the channel bottom from the service road. A bulldozer would stockpile sediment to a closer area and then stockpiles would be removed with an excavator.

Sediment removal would be performed in the summer when the stream may be dry. However, if water were still flowing in the channel, streamflow would be diverted around the project. Alternatively, for small projects a barrier would be constructed downstream. This barrier would consist of washed pea gravel that is brought in trucks, dumped and placed across the channel with the excavator or other equipment. The barrier would slow the flow of water, which would allow suspended sediment to settle out where it can then be removed.

In dry channels, a front-end loader or excavator would be used to remove sediment and debris from channels that are shallow enough that a loader or excavator can load a ten-yard dump truck from the channel bottom. The front-end loader would be driven along the channel bottom after being driven in on an existing ramp or over shallow sides. Sediment is sometimes cleared from only a portion of the channel (typically in the center part of the channel), with the remaining sediment build-up left in place to be carried downstream by high winter flows. Sediment and debris would be placed directly into 10-yard dump trucks or 20-yard semi-trucks on the channel bottom access ramp, and hauled off-site to a disposal area.

Before implementation of sediment removal activities, the sites scheduled for sediment removal would be evaluated by SCWA staff biologists to make any needed recommendations for protecting aquatic and riparian species and habitat. If the potential for salmonid species to occur in the area is identified, sediment removal operations would be modified to include a fish rescue by staff biologists. Fish rescue activities have not been needed in the past because of the poor-quality habitat that exists in the channels that typically accumulate sediment.

Grade-control structures and fish ladders under SCWA's jurisdiction would be inspected annually, and cleared of debris, as necessary, to protect the structures. Hand labor or heavy equipment (i.e., excavator or backhoe) would be used to clear debris from structures.

Large debris would be removed only from constructed flood control channels, flood control reservoirs, and to a very limited extent in natural waterways associated with emergency sediment maintenance and bank stabilization activities. It would be removed on an as-needed basis, as determined through the cooperative efforts of SCWA operations and maintenance personnel and fisheries biologists. Large woody debris would be allowed to remain in flood control channels if it does not threaten bank stability or the flow capacity of structures such as bridges and culverts. Removal of large woody debris or other structures providing fish habitat would only be performed if the debris were causing a significant erosion problem or flow blockage. Large anchored jacks that have come loose from their original placements and are found in the Russian River channel would also be removed on an as-needed basis.

3.4.2 Vegetation Maintenance

Vegetation maintenance on streambanks and within channels would be conducted by SCWA to maintain bed and bank stability on Dry Creek and the Russian River, and to maintain flood capacity for the natural waterways and constructed flood control channels. To meet the objectives of channel stability and flood control while protecting aquatic and riparian habitat, SCWA has refined its procedures for vegetation maintenance on constructed flood control channels and natural waterways (Tables 2-20 and 2-22). These practices, which differ significantly between the natural waterways and constructed flood control channels, are described below. SCWA has hydraulic maintenance easements that are permissive and allow SCWA to access various natural creeks to remove debris or vegetation to restore hydraulic capacity and to protect property. SCWA's proposed vegetation maintenance activities are described in additional detail below.

Channel maintenance activities in the Russian River and Dry Creek performed under USACE obligation include both vegetation and sediment maintenance. These activities are discussed separately.

3.4.2.1 Vegetation Management Practices in Constructed Flood Control

SCWA maintains approximately 150 miles of constructed flood control channels (Table 2-20). Most of these channels were designed to provide 100-year flood capacity. The original design capacity assumed that streambanks would be predominantly grass, with little or no tree growth, and the streambed would be maintained clear of vegetation and sediment.

A hydraulic assessment of selected Zone 1A constructed flood control channels was performed in 2000 to identify flood capacity under various vegetation management scenarios. (See Section 2.7, Table 2-21). The hydraulic assessment showed that for many of the channels, moderately dense shrubby vegetative growth with young developing willows (about 5 years old) on portions the streambank, and tule growth on the streambed, would cause impairment of hydraulic capacity, so that the 100-year flood might not be contained. Additionally, SCWA is currently reviewing a rainfall-runoff study conducted by USACE (2002). That study determined 100-year storm flows in the Santa Rosa Creek watershed are of a greater magnitude than had been historically calculated and used for the design of flood control channels.

To maintain constructed flood control channels, SCWA has apportioned the maintenance activities into five “zones”: top of bank, upper channel bank, middle channel bank, lower channel bank, and the channel bottom. Maintenance activities in top of bank and upper channel are consistent among all constructed flood control channels. Maintenance activities in the lower three zones (upper, middle, and lower channel bank) would vary depending on channel capacity and flood risk.

Top of Bank

The top of bank zone maintenance includes:

- landscape maintenance,
- fence/gate maintenance,
- V-ditch and drop inlet maintenance, and
- service road maintenance.

The access roads for the constructed flood control channels would be kept clear of vegetation with the use of residual herbicides, aquatic contact herbicides (which are effective only at the time of application [early spring]), and mowing. The portion of the channel between the access roadways and the fence lines that border the channels would be mowed twice annually for fire control purposes and structure integrity. In areas that do not contain access roads, an area of width 1.5 times the average height of the fuel source would be mowed adjacent to the fence lines. Mowing in this area would avoid native trees.

Upper, Middle, and Lower Banks

The upper and middle channel bank zones typically consist of the upper two-thirds of the channel bank (which is generally everything above five feet higher than the channel bed). The lower channel bank zone comprises the area in the lower third of the channel bank (typically lower than approximately five feet above the channel bed), including the toe of the channel.

The level of vegetation maintenance applied would depend on the hydraulic capacity required in the channel. One of three vegetation management practices would be applied, maintenance of the original design capacity, intermediate vegetation maintenance, or mature riparian vegetation maintenance.

<u>Original Design Capacity Maintenance</u>

A hydraulic assessment (ENTRIX, Inc. 2002c) indicates that to maintain original design flood capacity, it will be necessary for SCWA to keep vegetation from growing into a dense brushy stage. In site-specific areas where the hydraulic assessment (ENTRIX, Inc. 2002c) indicates that simulated flows are near or just over-bank, vegetation would be maintained at the original design capacity scenario. Vegetation maintenance practices may include more frequent maintenance; limiting vegetation on streambanks to predominantly grass with little or no woody stem growth; and maintaining the channel bottom clear of vegetation.

<u>Intermediate Vegetation Maintenance</u>

In some channels, vegetation may be allowed to grow while still maintaining sufficient hydraulic capacity. These are generally channels that have required maintenance every five years or more. The following maintenance practices would apply.

Thinning of under-brush and debris removal would take place in the upper and middle zone. Existing mature trees, which are predominantly within the upper third of the bank or at the top of bank, would not be removed unless dead, diseased, or downed and present a hazard to adjacent or downstream properties. The lower limbs of existing trees would be periodically thinned and removed in order to keep them above the floodway elevation (i.e., above top of bank).

Channel maintenance practices in the lower channel zone would consist of the removal of understory vegetation. Understory vegetation removal (e.g. blackberries) would be accomplished by hand-clearing and spray aquatic herbicides. Small, mechanized equipment may be used to transport the cut vegetation to the top of bank so that it may be efficiently removed from the channel. Removal of plants will be selective, based on the species present, with an emphasis on protecting native riparian species wherever possible. Native trees (typically willows) that are growing along the lower one-third of the bank, including the toe of the bank where it intersects the channel bed, would be allowed to colonize as young trees. These trees will provide shade and cover along the wetted channel bottom during the low-flow summer season. However, these young trees must be regularly maintained so that they do not cause significant impairment of flood capacity and do not provide an opportunity to catch woody debris during high-flow events. Therefore, the following guidelines will be used to maintain the young trees along the lower third of the bank:

- Willows (or other native riparian vegetation types such as cottonwoods and alders) would be allowed to grow to no more than one-half the total design depth of the channel. Thus, a channel with a design depth of 20 feet may have willows that grow to a height of approximately 10 feet. Young trees that exceed one-half the depth of the channel would be cut and stump-treated. Where possible, existing trees of 4 inches or larger may be retained in trade for removing smaller trees in the immediate area. Where hydraulic capacity would not be impaired, the growth of colonies of mature trees would be encouraged, spaced intermittently in the channel or for shading adjacent to pools.

- All limbs growing out from the main trunk will be pruned as the trees grow so that the lowest limbs are at least 5 feet above the ground elevation.

- Any trees with more than one developing trunk will be pruned to a single main trunk. Because arroyo willows take a shrubby form, this particular species will be completely removed from the channel whenever they are identified. However, if other trees are not there, some willows may be left.

- Initial spacing between colonizing trees will be approximately 15 feet. If tree canopies begin to fill-out so that they are overlapping or touching, then the spacing between trees will be increased by thinning.

<u>Mature Riparian Vegetation Maintenance</u>

Complete canopy cover along the channel would be achieved by allowing the development of mature, single-trunk trees with most of the canopy above the floodway elevation. Native trees would be maintained (thinning or pruning) or planted. Vegetation at the channel toe and in the lower third of the bank would be maintained parallel with the flow and spaced 15 to 25 feet, depending on species. Lower limbs would be pruned to maintain channel capacity. In order for a mature canopy cover to be achieved, adequate flood capacity must exist in the channel both during the period when young trees are growing within the floodway and at later mature stages when these trees have canopies that rise above the floodway elevation.

Mature trees and plantings would increase the riparian habitat value of the channel over original design capacity (baseline conditions) or intermediate vegetation maintenance. An example is the riparian corridor that has developed along a restored section of Brush Creek (Section 3.5.2). On this creek, trees were planted in a fairly straight line parallel to the stream, providing riparian vegetation while minimizing reduction of hydraulic capacity.

Channel Bottom

The channel bottom of constructed flood control channels would be cleared of vegetation through the use of spray aquatic contact herbicides and hand clearing. Future selected vegetation clearing from the channel banks may be necessary to allow access to the channel bottoms for silt removal operations. Small, mechanized equipment may be used to transport the cut vegetation to the top of bank so that it may be efficiently removed from the channel.

Level of Vegetation Management in Constructed Flood Controls

Table 3-6 lists the flood control channels and an estimate of the level of maintenance that would be performed (see Figure 2-26). This table shows that portions of some channels with potential salmonid habitat would require original design capacity maintenance practices, including Paulin, Piner, Santa Rosa, Brush, Crane, Laguna de Santa Rosa, Rinconada, and Todd creeks. Additional channels that require this level of maintenance are thought to act as a migration corridor only. An adaptive management approach (described in the following section) would be implemented to assess which channels may in the future have maintenance protocols that allow more vegetation to grow.

For bridges and culverts that do not have the capacity to pass the 100-year discharge under the intermediate maintenance, it would be necessary to implement original design capacity vegetation maintenance practices near the bridge structures. These may include removing all vegetation except grasses within approximately a distance equal to the channel top-width both upstream and downstream from the bridge.

Since vegetation removal practices were modified in the last few years, significant tree growth has occurred on several engineered channels such as Brush Creek, Santa Rosa Creek, and Hinebaugh Creek. This vegetation may need to be thinned, pruned, or removed.

SCWA also has vegetation maintenance responsibilities on a section of Santa Rosa Creek for the Prince Memorial Greenway restoration project and for a restoration project on the lower reaches of Brush Creek. In general, these responsibilities include maintaining vegetation that has been planted along the streambanks for each of these projects (on Brush Creek vegetation is not cut on the lower one-third of the streambank), so that there is no loss of the riparian canopy. SCWA is responsible for channel maintenance of these restored flood control channels and will implement the least intrusive maintenance protocol that provides flood protection.

Channel Capacity Assessment

SCWA is currently in the process of further reviewing the recent USACE (2002) rainfall-runoff study to determine the extent to which peak flood flows in the Santa Rosa Creek drainage exceed flood peaks used as the basis for the original design of the flood control channels. SCWA will also be performing additional hydraulic modeling to assess the capacity of their flood control channels.

Table 3-6 Levels of Vegetation Maintenance Work in Flood Control Channels[1]

Creek	Summer Flow[2]	Species Known to Occur[3]	Potential to Support Spawning/Rearing Habitat
Streams that Require Original Design Maintenance Scenario			
Migration, Rearing, and Spawning			
Paulin	Yes	St	Yes
Piner			Yes
Santa Rosa	Yes	Co, St	Yes
Migration and Rearing			
Brush		St	Yes
Crane			Yes
Laguna de Santa Rosa	Yes	St	Yes
Rinconada	Yes		Yes
Todd		St	Yes
Migration Only[4]			
Austin[5]		St	Yes
Coleman			
Colgan			
Copeland			
Cotati			
Ducker			
Five			
Forestview			
Hinebaugh			
Kawana			
Lornadel			
Roseland			
Gossage / Washoe			
Wilfred	Yes		
Windsor	Yes		
Streams that Require Intermediate Vegetation Maintenance			
Migration, Rearing, and Spawning			
Oakmont	Yes		Yes
Migration Only[4]			
College			
Faught			
Hunter Lane Channel		St	Yes
Indian			
Peterson			
Russell			
Spivok			
Starr			
Steele			
Wendel			
Windsor tributaries			

Table 3-6 Levels of Vegetation Maintenance Work in Flood Control Channels[1] (Continued)

Creek	Summer Flow[2]	Species Known to Occur[3]	Potential to Support Spawning/Rearing Habitat
Streams with Mature Riparian Vegetation Management			
Sierra Park			
Spring			
Wikiup			

[1]Source: SCWA (Paul Valenti and Bob Oller, Operations & Maintenance Department).

[2]Summer base flow that is not supported by relatively recent urban runoff. Portions of these channels dry up in summer, but other portions retain base flow.

[3]Where rearing activity occurs, species are listed if known. Salmonids may use other channels currently or in the future. Co = coho salmon; St = steelhead

[4]Migration corridor assumed to be a function of all flood control channels.

[5]Austin Creek in Rincon Valley, not in West Sonoma County.

If USACE analysis is verified, SCWA will evaluate various flood-control options to address the higher peak flows. Zone 1A flood control channels and flood detention basins will be assessed to see if they provide 100-year flood protection. Revised channel maintenance practices in combination with new or redesigned flood control facilities may be necessary. The specific mix of options available to achieve flood protection will be evaluated based on a more detailed understanding of peak-flood magnitudes associated with each of the sub-basins contributing to the Santa Rosa Creek watershed and the engineering feasibility of various design options. From the hydrologic and hydraulic modeling results, a range of opportunities will be investigated to determine if there are feasible methods for reducing flood peaks in order to contain the 100-year flow.

The results of these technical studies will be used to form the basis of an adaptive management approach. The effects of vegetation management protocols on flood capacity will be monitored and evaluated to determine if modifications to the protocols are appropriate. If a channel exhibits less capacity than modeled, additional measures would be implemented to improve capacity. If a channel exhibits greater flood capacity, the management protocols would be modified to allow more vegetative growth if needed to support habitat value of the channel.

Where feasible methods to reduce flood peaks are identified and developed, and adequate channel capacity can be maintained, SCWA would allow more mature or more dense vegetation to grow in the constructed flood control channels than is currently proposed.

Site-specific areas would be evaluated for ways to increase channel capacity while reducing effects to, or increasing habitat value for, salmonids. One option would be to lower one of the two service roads along a channel so that it becomes part of the high-flow channel, thereby increasing cross-sectional area. A service road that is at the top of a levee or bank can be lowered by excavating a portion of the top of the bank, thereby increasing channel capacity. This action would be feasible only in channels that have a sufficiently wide right-of-way between the existing service road and the bordering fence line to provide enough room for a stable bank after excavation and lowering of the service road. Lowering the service road would be considered only in areas that currently require frequent maintenance or where design flood capacity is currently insufficient. The locations where the service road could be lowered and where this would be desirable to improve flood capacity would be identified and evaluated for potential modification. Increasing channel capacity in this manner could enable the creek to be managed with more mature riparian vegetation and a more natural geomorphic and ecological form.

In areas where it would be feasible, some of the bar features within the channel would be retained. This would occur while still maintaining adequate channel capacity, and where improved passage to upstream rearing or spawning habitat would be beneficial. Enough instream vegetation and/or sediment would be removed to maintain channel capacity, but some of the root structure would be left in place to stabilize the bars in the low-flow channel and maintain deeper water depth for fish passage.

3.4.2.2 Vegetation Management Practices in Natural Channels

For the natural channels (other than the Russian River and 15 channel improvement sites along Dry Creek) where vegetation removal may occur, SCWA does not have routine or regularly implemented maintenance obligations. Maintenance on natural waterways (Table 2-22) would consist of clearing vegetation from the bottom of natural waterways to restore hydraulic capacity. Hand labor is the typical clearing method. Heavy equipment would only be used to lift out or clear debris jams not accessible to hand crews.

One of the goals of SCWA's riparian enhancement projects is to create a shade canopy over the stream channel, which reduces plant growth on the channel bottom, and in turn helps maintain hydraulic capacity. In accordance with this goal, native trees growing along stream banks have been allowed to establish. Some vegetation understory along the channel banks and in the main channel that could substantially reduce hydraulic capacity would be removed by mowing (upper third), hand clearing, or spray, as needed. This practice would be implemented by SCWA staff, including both operations and maintenance personnel and staff biologists. SCWA staff may occasionally need to use herbicides (approved for aquatic use) and/or hand labor to remove invasive exotic species. Native vegetation would generally not be removed unless it presents a significant flood risk.

SCWA staff have observed, through various maintenance and riparian enhancement projects, the effectiveness of maintaining (thinning or pruning) or planting native trees along the streambank in a fairly straight line parallel to the stream. These trees and plantings have increased the riparian habitat value of the stream. This procedure for riparian enhancement plantings would continue to be implemented as part of SCWA's fisheries and riparian restoration projects in the Russian River watershed.

Vegetation control along the levee access roads of the Mirabel/Wohler diversion facilities would be done as needed using contact herbicide applications (Rodeo) and hand removal. Blackberries that grow in channels connecting the diversion at the Russian River with the infiltration ponds would be removed by hand once a year. Mowing on levee roads generally would occur in late spring each year.

3.4.3 Bank Stabilization in the Russian River and Dry Creek

SCWA and MCRRFCD were designated as the local agencies responsible for channel maintenance below WSD and CVD, in Sonoma and Mendocino counties, respectively. SCWA's and MCRRFCD's bank stabilization activities on the Russian River and its tributaries would be limited to maintenance of past channel improvement projects. Several projects were implemented by USACE on the Russian River from RM 98 near Calpella to approximately RM 40 in Healdsburg. In addition to maintaining channel improvements installed for CVD, SCWA, and MCRRFCD would continue to inspect channel improvement sites that were constructed between 1956 and 1963.

MCRRFCD conducts channel maintenance in Mendocino County. MCRRFCD was the lead agency on two non-project levees under Public Law 84-99, located in Hopland on Fetzer Vineyard properties and at the Calpella County Water District. USACE conducted annual inspections of these levees and, along with the landowner, was responsible for the repair of the levees. The Fetzer Vineyard and Capella County Water District sites are now out of the active USACE program.

Dry Creek

Channel maintenance activities on Dry Creek are limited to maintaining USACE channel improvements at 15 locations that were installed to prevent bank erosion following construction of WSD. These improvements are identified in the USACE operation and maintenance manual prepared in July 1991 (USACE 1991). Under the proposed project, SCWA would continue to maintain these 15 channel improvement sites. Maintenance work associated with these sites can involve incidental sediment removal, vegetation removal, removal of debris, and bank stabilization. Vegetation removal would only occur to improve bank stability if trees are leaning or otherwise directing high flows against the bank, causing erosion, and to visually inspect a bank stabilization structure. Bank stabilization work typically would involve replacing lost riprap and, if necessary, re-grading the bank slope to its previous contours in order to provide a stable base for the riprap. Riparian vegetation on the channel banks and bars would be left in place, if not threatening bank stability, in order to maintain shade for aquatic habitat.

Outside of the work done on the 15 grade and bank erosion control structures, additional vegetation removal for flood control or bank erosion is not a USACE obligation and would not be performed in Dry Creek. However, limited work may be performed in Dry Creek, specifically at landowner request in response to extreme flood flows that result in bank erosion that threatens property or structures. This type of work would occur infrequently.

SCWA would continue to inspect the one nonfederal levee (Public Law 84-99) on Dry Creek. The property owner is responsible for needed repairs.

Russian River

Under the proposed project, SCWA and MCRRFCD channel maintenance activities would be conducted in the Russian River. The channel improvement sites and levees in the Russian River would be inspected periodically by USACE and SCWA. USACE would then recommend maintenance work that may be needed. In general, SCWA and MCRRFCD would be required to keep the project levees free from vegetation, remove instream gravel bars that may be impeding flow, and inspect and maintain the channel improvement sites. Typical maintenance activities for channel improvement sites in the Russian River are similar to those on Dry Creek, and include removing loose anchor jacks from the river, repairing and replacing loose grout or riprap, adding bank erosion protection at sites found to be eroding, and managing vegetation and removing flood debris to reduce blockage of the river channel that is causing bank erosion or preventing inspection of channel improvement sites.

Repairs to bank stabilization structures in Dry Creek and the Russian River would be as needed when identified during USACE inspections, and would employ BMPs to minimize disturbance to listed species during construction activities. Large anchored jacks that have come loose from their original placements and found in the river channel would be removed. Vegetation removal at bank stabilization structures would only occur if vegetation threatens the integrity or function of a structure. Sediment removal would be conducted to prevent flows from being directed toward a bank that is eroding.

Inspections of nonfederal levees would be performed by SCWA, but if major repairs were needed, the property owner and USACE would be notified.

3.4.3.1 Gravel Bar and Overflow Channel Maintenance in the Mainstem Russian River

Under the proposed project, MCRRFCD would perform streambank maintenance consisting of obstacle removal, streambank repair, and preventive maintenance over a 36-mile reach of the Russian River in Mendocino County. SCWA would perform streambank maintenance in the mainstem Russian River in Sonoma County. However, gravel bar grading activities under the proposed project would be more limited than under baseline conditions, and protocols would be implemented to reduce the potential for negative effects on salmonid habitat.

Conservation measures provided in the terms and conditions of BOs issued by NOAA Fisheries to Syar Industries and Shamrock Materials, Inc. for instream gravel mining operations, as well as measures in the ARM Plan, may be useful to implement in the proposed project for bank stabilization work in the Russian River. However, streambank stabilization is very different from gravel extraction, and, therefore, conservation measures will differ as well.

Bank erosion occurs when flow is directed into the riverbank by large gravel bars that are often well vegetated. To reduce bank erosion in the mainstem Russian River, instream gravel bars that contribute to bank erosion would be re-graded, and overflow channels would be created to direct the river channel away from susceptible banks. Maintenance work would be directed toward reshaping and removing a portion of these bars. This action specifically addresses sites where the formation or growth of gravel bars is likely to cause severe bank erosion.

MCRRFCD has identified approximately 23 sites along the river in Mendocino County that have required maintenance work in the past (MCRRFCD 2003). Areas identified as problem areas are usually located at curves in the river. Three to four sites have been worked on annually. The selected sites ranged in size from very small areas to reaches up to 100 yards in length. Under the proposed project, MCRRFCD would continue to assess approximately 12 miles of river each year and would limit the size of the sites to between 10 feet and 300 feet in length. Up to three or four sites would continue to be selected on the basis of need for streambank erosion control. CDFG staff would continue to participate in site visits and evaluate site selection.

SCWA would also limit this maintenance work in the river in Sonoma County to no more than three to four sites per year.

Protocols would be implemented to reduce effects to salmonid habitat. The gravel bar grading protocols are listed in the following section.

USACE would, in cooperation with NOAA Fisheries and CDFG, review the sediment and vegetation control obligations contained in the USACE O&M manuals and modify them to minimize the effects of channel maintenance activities on listed fish species. These modifications would be identified in the Section 404 permits required for the channel maintenance activities.

MCRRFCD would continue to assist property owners with bank stabilization on the upper Russian River in Mendocino County by being the lead agency, when necessary, for obtaining public law funding when major bank failures have occurred. MCRRFCD would also encourage property owners to stabilize their banks by planting native vegetation along the banks to reduce erosion.

Gravel Bar Grading Protocols in the Russian River

Certain conditions may warrant some degree of channel maintenance. Channel maintenance activities may be conducted if one or more of these conditions exist:

1. Occurrence of severe bank erosion

2. Recent substantial changes in channel morphology that are likely to lead to severe bank erosion

3. Evidence of weakened levees

4. Threats of flooding to infrastructure or private property

Gravel bar grading would not be conducted unless there is evidence of severe bank erosion, or recent substantial changes in channel morphology suggest that severe bank erosion is likely during the next rainy season. Gravel bar grading would be conducted in a manner that provides increased protection for the low-flow channel and native vegetation, and reduces the need for channel bar grading. A qualified fish biologist would evaluate the habitat and biological features of each proposed site prior to implementation of grading. Project planning would be coordinated with NOAA Fisheries and CDFG.

The maintenance work would consist of grading bars in the channel during the dry summer season during low-flow periods and creating an overflow channel if needed. Maintenance work would occur between July 1 and October 1 to avoid spawning and incubation periods.

No grading would be conducted in the low-flow channel. Buffers (i.e., areas of undisturbed habitat) would be maintained along the edge of the low-flow channel to help maintain bar form, prevent deposition of material into the river, and to keep heavy equipment out of the wetted channel. Where vegetation is present, a buffer width of at least 25 feet or 10 percent of the bar width, whichever is less, would be maintained along the edge of the low-flow channel. Where no vegetation is present, a buffer width of at least 25 feet or 10 percent of the bar width, whichever is less, would be maintained. A buffer along the bank/levee side of the bar would be maintained to reduce erosion along the bank.

If a channel bar is graded, the elevation of the post-graded bar would be at least 1.5 feet higher than the elevation of the edge of the low-flow channel to maintain the thalweg of the channel. Sediment would be contoured to create a slope that runs up and away from the centerline of the main low-flow channel at a two percent grade from the WSE at low flow, or baseline elevation at the water surface, whichever is higher. The slope parallel to the flow of the river would be consistent with the adjacent stream grade.

Openings would be provided on the downstream end of the bar on the buffer zone to provide even drainage and to decrease the risk of juvenile salmonid stranding when high flows recede. A maximum of four openings per bar would be provided within the downstream-most 20 percent of the bar. These openings would not substantially exceed the width of a single bulldozer blade.

Any large woody debris that is moved or extracted would be deposited either on the upstream buffer area or along the low-flow channel buffer where it can be redistributed in the high flows of the next rainy season. If it poses a risk to property, it may be anchored or placed elsewhere in the river.

This work would be primarily performed using heavy equipment, such as front-end loaders, an excavator with an extended arm and thumb as well as an appropriately sized bulldozer. Equipment fueling and maintenance would be conducted outside of and away from the river channel. Because gravel bars do not always form in the same river sections over the years, new access roads may be required. Where possible, existing access roads would be used, and construction of new access roads would be limited to the fullest extent possible. Road widths would be limited to a width that allows one vehicle to pass. If needed, up-slope sediment control measures such as silt fences would be installed to reduce sediment input to the stream channel.

Gravel bar grading would be limited to that material necessary to reduce the risk of bank erosion. If necessary, gravel would be removed from the channel. Gravel removed from the lower Russian River may be relocated to Dry Creek (on USACE property at the head of the creek) as part of restoration activities, after written notification of and approval by NOAA Fisheries. An assessment would be made of how much gravel could be placed in Dry Creek without altering channel morphology. If future restoration actions in the East Fork or the mainstem upstream of the Forks require gravel supplementation, gravel could also be made available for those projects as well.

It should be acknowledged that natural riverine processes may tend to redeposit gravel and other sediments in areas that have been graded, and that ongoing maintenance may be needed. However, the goal of this action is not to stop re-formation of gravel bars, but to manage them in such a way to reduce the risk of extensive bank erosion that accompanies bar development. Section 3.4.3.3 describes a monitoring program that will identify areas subject to frequent or extensive maintenance and outlines potential alternatives to address bank erosion at those sites.

3.4.3.2 Vegetation Maintenance in the Mainstem Russian River

Under the proposed project, MCRRFCD would continue to perform vegetation maintenance to control bank erosion. Vegetation would be removed from gravel bars that contribute to bank erosion, implementing the following protocols that limit the potential for negative effects on salmonid habitat.

Vegetation Maintenance Protocols in the Russian River

Vegetation maintenance work may be conducted if one or more of these conditions exist:

1. Encroachment by *Arundo donax* or other exotic pest plant species
2. Occurrence of severe bank erosion
3. Recent substantial changes in channel morphology that are likely to lead to severe bank erosion
4. Evidence of weakened levees
5. Threats of flooding to infrastructure or private property

Invasive plant species like *Arundo donax* may be burned in place or uprooted and destroyed outside of the river channel. *Arundo donax* may be mulched using equipment appropriate for this species. In areas where infestations are extensive, heavy equipment such as backhoes, front-end loaders, and bulldozers may be used. Alternatively, *Arundo* may be cut off near ground level and the stump treated with an appropriate, approved, herbicide. If effective new treatments are developed in the future for *Arundo* control, they may be implemented. The objective of these treatments is to kill all *Arundo donax* to prevent recolonization by plant tissue.

Vegetation maintenance may be conducted in conjunction with gravel bar grading activities related to streambank erosion control. Vegetation maintenance activities would be conducted in a manner that provides increased protection for the low-flow channel and native vegetation, and reduces the need for channel bar grading. A qualified fish biologist would evaluate the habitat and biological features at each site prior to implementation of vegetation removal. Project planning would continue to be coordinated with CDFG.

Vegetation maintenance would not be performed unless these conditions prevail: there is evidence of severe bank erosion, recent substantial changes in channel morphology suggest that severe bank erosion is likely during the next wet season, or if removal of exotic invasive species is required. The vegetation maintenance work would be implemented during summer season low-flow periods between July 1 and October 1 to avoid salmonid spawning and incubation periods.

Vegetation removal would occur in a managed zone consisting of an area outside of the low-flow channel and outside a 25-foot vegetation buffer zone next to the low-flow channel. In channels that are wider than 200 feet, a vegetation buffer zone of at least 50 feet wide would be maintained.

Vegetation in the buffer zone along the low-flow channel may be cropped. Vegetation that is too large to mow would generally be removed by hand. However, if removal of willows and other vegetation in the managed zone cannot be accomplished through mowing or hand removal, other heavy equipment such as bulldozers may be used. To the extent possible, mechanical methods that leave roots of native species intact would be selected to minimize sediment re-suspension and changes to gravel bar morphology during high flows. In some cases, more aggressive practices may be required to reduce the frequency of vegetation maintenance. In these cases, stumps of larger trees may be treated with contact herbicides, or willow roots may be removed.

Native vegetation that is removed in the management zone would be relocated to the extent possible. The removal of vegetation would include the subsurface material including the root structure. Willow saplings would be replanted along the low-flow-channel buffer, along the outer riverbank, or within the upper bar buffer to encourage new riparian growth. Planting trenches would be prepared to accept larger willow plants that could sprout new plants. Trenches would be excavated five to six feet wide and about three to five feet deep, or deep enough to reach groundwater. Any vegetation removal that requires gravel bar grading would implement gravel bar grading protocols outlined in the preceding section.

Vegetation removal would be scheduled so that gravel bars are worked on in rotation over a course of three to five years. Gravel bars would be assessed to identify those that require work. These gravel bars would then be scheduled for work during different years. Once a gravel bar has been worked on, it would be left alone for three to five years before it is worked on again. In this way, some bars would always have willows that provide high-flow velocity refuge areas for salmonids.

3.4.3.3 Site-Specific Bank Stabilization in the Russian River

Areas along the mainstem Russian River where frequent and/or extensive channel maintenance actions are required to prevent bank erosion would be identified. This information could then be used to assess whether these sites may be candidates for bank stabilization projects.

The location, frequency, and extent of channel maintenance work would be recorded as work is conducted. If specific areas require maintenance work involving gravel bar grading and construction of an overflow channel on a frequent basis (e.g., 3 out of 5 years), the potential to use other bank stabilization methods would be evaluated. SCWA or MCRRFCD would not be required to install bank stabilization projects other than bank revegetation. Where appropriate, revegetation plans to enhance the riparian habitat and bank protection would be limited to planting of native riparian species.

SCWA or MCRRFCD may coordinate potential bioengineered or engineered bank stabilization projects with local landowners or with the USACE, if persistent and severe bank erosion is identified in areas that threaten the integrity of structures and property. SCWA or MCRRFCD may be the lead agency on public-law funding when major bank failures occur. NOAA Fisheries would be notified of proposed bank stabilization structures and a request for approval would be made. If more than 1,000 feet of channel are to be affected by any single project or if the project is within 1,000 feet of a previously armored site, a separate ESA Section 7 consultation would be initiated for that action associated with the respective USACE 404 permit. The intent is to avoid large segments of continuous hard-armoring within the mainstem from cumulatively developing. If bank stabilization activities are implemented, bioengineered structures would be used whenever possible. Where bioengineered bank stabilization methods are not deemed to be practical, then priority would be given to incorporating vegetative plantings into the hard-armoring techniques that are implemented. Fish habitat restoration elements (such as native material revetments) would be incorporated into bank stabilization practices when feasible, with the intent of replacing lost habitat.

Installation of engineered, hard-armor bank stabilization structures may increase the risk that future streambank erosion problems may appear upstream or downstream of the bank stabilization site. Therefore, it may be preferable to implement gravel bar grading and overflow channels on a regular basis at some sites, rather than to implement hard-armoring bank stabilization projects.

3.4.4 Bank Stabilization in Natural Waterways

Through the FEP, SCWA has worked with local landowners to implement bioengineering projects to assist with bank erosion problems. This change in bank stabilization procedures has assisted landowners in protecting the streambank and has improved riparian and fisheries habitat along the Russian River and its tributaries. Examples of SCWA projects are provided in Section 3.5.

Occasionally, bank stabilization and sediment removal would be performed on natural waterways, including the Russian River, in response to bank erosion after unusually large storm events at the request of the landowner. In recent years, this type of work was performed on Austin Creek and Big Sulphur Creek.

The Big Sulphur Creek work serves as an example. In September 1995, SCWA was the local sponsor for a project to remove sediment from the channel, which had aggraded approximately 8 to 10 feet due to landslides the previous winter. In October 1997, another sediment removal project was necessary following the large storm events in January 1997. In both cases, the channel aggradation posed a significant flood risk to the surrounding area; thus, the activity was treated as an emergency repair action.

Potential activities would include bank stabilization, levee repair, vegetation or sediment removal, or channel realignment. These activities would be initiated only by a request from a private landowner after a washout threatens property or structures. Based on past history, such activities occur about once every five to ten years. Typical project lengths under these circumstances are approximately 500 feet, but could be up to 1,000 feet. SCWA would not implement bank stabilization or sediment removal activities in natural channels if more than 1,000 feet of channel would be affected by any single project. As described earlier, a separate ESA Section 7 consultation would be initiated for actions that affect more than 1,000 feet of channel or would be within 1,000 feet of a previously armored site.

Potential direct and indirect effects of a project to salmonid habitat would be considered during project planning and efforts made to reduce adverse effects to listed species. Construction would occur during the summer to avoid spawning and egg incubation periods. Before any activity is implemented, the site would be assessed with a qualified fisheries biologist. Feasible alternatives would be considered, and plans would be developed in consultation with CDFG. The planning phase would include an assessment of habitat and biological resources in the area, and consideration of those factors that may have contributed to the washout or sediment deposition.

Bioengineered bank stabilization methods would be given priority on smaller channels (less than 50 feet wide), when they are deemed to be a feasible and effective treatment. In larger channels were bioengineering techniques would not be feasible or effective, riprap or other hard-armoring measures may be used. Vegetative plantings would be incorporated into these bank stabilization measures as feasible. Fish habitat restoration elements would be incorporated into bank stabilization measures where feasible. Examples of such measures include the use of native material revetments, which combine boulders, logs, and live plant material to armor a streambank (as outlined in Flosi et al. 1998). Revegetation with native plant species would always be implemented in association with bank stabilization measures if site conditions are suitable.

As part of bank stabilization efforts, it is also sometimes necessary to remove deposited sediments or vegetation growing on bars. Preference would always be given to thinning vegetation on gravel bars, which allows gravel to move over time so that it does not have to be excavated with heavy equipment. However, bars would be removed if necessary to prevent erosion that would occur if flows are directed into vulnerable streambanks by the bar deposit. If large woody debris is present in the excavated sediment deposits, it would be removed from the stream only if it threatens to de-stabilize a section of streambank. Otherwise, the large woody debris would be allowed to remain in the channel. On occasion, it is preferable to straighten a short portion of the channel by cutting off a meander instead of excavating the bar sediments if the bank cannot be sufficiently stabilized by other means. If this re-alignment practice is used, SCWA would consider replacing any lost habitat by incorporating native material revetments as discussed above.

Standard BMPs would be applied to work in natural channels. If possible, sediment excavation and bank stabilization would be performed under low-flow conditions, generally during the summer or fall months. If the channel is not dry, flows would be diverted, typically using earthen cofferdams, pea gravel, or, if necessary, a clean bypass. A fish biologist would inspect the reach where dewatering must occur to allow in-channel work. Fish rescues would be conducted, if necessary. Work would be performed using backhoes, excavators, and dump trucks, depending on the site configuration and available access. BMPs for operating equipment in or near an active channel would be followed as outlined in Section 3.4.1.4.

3.4.5 Gravel Bar Grading in the Mirabel/Wohler Diversion Area

Gravel bar grading would continue to be conducted in the Russian River near the Mirabel/Wohler Diversion areas. The protocols for gravel bar grading operations conducted to increase infiltration capacity may differ from those conducted for channel maintenance. Therefore, these activities are discussed separately.

Infiltration capacity at the Wohler and Mirabel diversion facilities would be augmented by periodically recontouring three gravel bars in the Russian River upstream of the inflatable dam (Wohler, McMurray, and Bridge gravel bars) and excavating one bar (Mirabel Bar) downstream of the inflatable dam near the Mirabel infiltration ponds. Work in other gravel bars may be required in the future if the pattern of gravel bar formation in the river changes so that new bars are formed. The McMurray and Mirabel bars are approximately 1,000 feet long and 200 feet wide. The other two gravel bars are about 500 feet long and 100 feet wide.

Gravel bar skimming operations would be performed on the Wohler, McMurray, and Bridge gravel bars in the spring of each year (or as needed) when streamflows drop below 800 cfs, and before the dam is inflated. When this work would be performed would vary, depending on the flow in the river and demands on the water system, but would generally occur between March and July. The Mirabel gravel bar would be excavated between July and October, depending on flow conditions.

Gravel at these locations would generally be pushed up on the bank using bulldozers and scrapers; in the future some may be removed and stockpiled. The material from the Mirabel gravel bar would be removed and hauled away. The largest of these bars (McMurray Bar) forms approximately 2,000 feet upstream of the Wohler Bridge near the mouth of Porter Creek. At flows above 800 cfs, the McMurray Bar is not accessible. There is a secondary channel between the McMurray Bar and the northern bank. When the water level in this secondary channel drops below about 3 feet at the crossing point, equipment would be moved out onto the bar to conduct grading operations.

The Bridge Bar is located on the north (Mirabel side) bank of the river near the Wohler Caissons. A second smaller bar located near the SCWA's Mirabel collectors is also skimmed each year. The Wohler gravel bar is located on the eastern shore of the Russian River near Caisson Number 1. Gravel at this bar would either be pushed into piles along the banks, or removed from the bar using scrapers and placed in a stockpile located between Caisson 2 and Wohler Bridge. The Mirabel Bar is located near Caisson 3 on the northern side of the Russian River. Gravel from this bar would be removed, using bulldozers and scrapers, and placed in a stockpile north of infiltration pond number 1, shown in Figure 2-24. Gravel from both the Mirabel and Wohler stockpiles would be removed by gravel contractors.

After gravel bar grading operations are completed, gravel bars would be contoured to reduce the potential for fish stranding. The elevation of the post-graded bar would be at least 1.5-feet higher than the elevation of the edge of the low-flow channel to maintain the thalweg of the channel. Sediment would be contoured to create a slope that runs up and away from the centerline of the main low-flow channel at a 2 percent grade from the low-flow WSE, or baseline elevation at the water surface, whichever is higher. The slope parallel to the flow of the river would be consistent with the adjacent stream grade.

The spoils from the gravel bar grading operations would be mounded in the riverbed, but if the volume of gravel is very large, they may have to be relocated or stockpiled outside of the floodplain. The sediment size varies from year to year but is generally fine material. The operation would be done during the dry season (e.g., July in 1999), and, if necessary, a cofferdam would be built to keep water out of the work area. The cofferdam would be breached to let water in once the sediment is removed.

The area and volume of sediment removed from the gravel bars would vary from year to year. In summer 1999, about 6,500 cubic yards of gravel were removed in the Mirabel area and in 1998, 1,650 cubic yards. In 1999 in the Mirabel area, two D-6 Cats, a motor grader, and a water truck for dust control were used. The equipment entered the bar from the west bank.

The following BMPs for gravel bar grading operations were evaluated by SCWA during a five-year monitoring study (Chase et al. 2000) and will be implemented as part of the proposed project:

1. Biological oversight will be provided by fisheries biologists. SCWA biologists will inspect the gravel bars before beginning gravel skimming work to 1) evaluate the need for silt fences, and 2) identify environmentally sensitive areas.

2. Permanent vegetation on the riverbanks will not be removed.

3. Sediment fences will be employed to prevent the input of sediment into the river.

4. Cofferdams will be constructed both upstream and downstream of the work areas, if necessary, to allow access to the work areas.

5. Operation of heavy equipment in the active stream channel will be limited to moving equipment to and from the mid-channel gravel bars and breaching cofferdams when needed, and will be very short in duration. All equipment will be removed from the gravel bars at the end of each day.

6. No fueling or equipment service will be performed on the gravel bars or within the active floodplain.

7. Gravel skimming operations will be limited to material above the waterline.

8. After gravel bar grading operations are completed, gravel bars will be contoured to 2 percent grade to reduce the potential for stranding fish.

9. Continuously recording turbidity meters will be installed upstream and downstream of gravel bar grading operations.

Breaching of the lower berm for the Mirabel Bar will be conducted late in the evening or early in the morning to reduce visual effects to recreational visitors to Steelhead Beach.

3.4.6 NPDES Permit Activities

Several activities are undertaken by SCWA, the City of Santa Rosa, and the County of Sonoma under an interagency agreement for an NPDES permit. Many of the channels listed in Table 3-7 are the Zone 1A channels maintained by SCWA for flood control purposes, which are also included in the NPDES permit area. Additional creeks will be included in Zone 1A under a new permit to be issued in June 2003.

Table 3-7 NPDES-Permitted Channels in the Zone 1A, 4, and 5 Areas (Portions Thereof)

Austin Creek	Hunter Lane Channel	Moorland Creek	Santa Rosa Creek
Brush Creek	Indian Creek	Oakmont Creek	Sierra Park Creek
Coffey Creek	Kawana Springs Creek	Paulin Creek	Spring Creek
Colgan Creek	Lornadell Creek	Piner Creek	Steele Creek
College Creek	Matanzas Creek	Roseland Creek	Todd Creek

SCWA, the City of Santa Rosa, and Sonoma County have undertaken the following related to storm water discharge under the NPDES permit:

1. The County Board of Supervisors' adoption of a Vineyard Erosion and Sediment Control Ordinance that will help protect creeks.
2. Collection of composite grab samples for chemical analysis during storms to evaluate possible trends or specific constituents.
3. Enforcement of existing and new development standards to protect creeks and prevent erosion.
4. Outreach efforts undertaken to educate the automotive industry, construction industry, landscape industry, carpet cleaners, high schools, colleges, and food service businesses in pollution prevention, and BMPs.
5. SCWA implementation of an education program for students and teachers about local watershed issues, pollution prevention, and stream protection.
6. Presentation of erosion control seminars to local homebuilders.
7. Improvement of responses to spills in storm drain facilities within the NPDES permit boundary. Response procedures for spills and erosion control violations have been standardized. Each year of the permit (1997-2000), between 91 and 230 spills have been responded to, resulting in the removal of a large variety of pollutants from the stream. These pollutants have included constituents such as antifreeze, petroleum products, diesel, sewage, corrosive parts cleaner, paint-contaminated water, and cement-contaminated water.
8. Improvement of the City of Santa Rosa storm drain cleaning system by implementing a dedicated maintenance crew and computerizing the cleaning tracking system.
9. Stream cleanup efforts, including removal of shopping carts, trash, tires, car batteries, mattresses, and other large items. Also, canopy cover on some streams was raised to discourage encampments.
10. City of Santa Rosa implementation of an Integrated Pest Management (IPM) program that includes a reduction in the use of pesticides. Herbicide use has also been reduced through the use of non-chemical vegetation control methods (e.g., weed mowers, hoeing, hand pulling, and mulching).
11. SCWA and City of Santa Rosa implementation of a creek stewardship program.

The NPDES permit activities related to storm water discharges in the Santa Rosa area reduce pollution in the streams in SCWA's Zone 1A channel maintenance area, which provides a benefit to salmonid and other aquatic species.

3.5 RESTORATION ACTIONS

SCWA has implemented, and would continue to implement, many actions that are designed to contribute to the restoration of natural resources in the Russian River watershed, particularly species listed under the ESA. These efforts include support for state and federal recovery plans; watershed management; riparian and aquatic habitat protection, restoration, and enhancement; and water conservation and recycling.

SCWA commits substantial funds, staff, and equipment to these restoration projects. SCWA has spent approximately $800,000 per year on its Natural Resources program, about 30 to 40 percent on monitoring at the Mirabel and Wohler diversion facilities (which has yielded valuable information about how listed fish species use the watershed), about 50 percent on FEP projects, and about 10 percent on meetings. Additionally, SCWA commits in-kind contributions of staff and equipment to restoration projects. For example, the in-kind contribution for restoration work on Big Austin Creek was $7,000 and on Copeland Creek was $31,000. SCWA secured an additional $471,000 in grants in 2000, and additional grant money will be pursued in the future.

To maximize the effectiveness of the dollars invested, SCWA develops project priorities on a basin-wide level, in cooperation with CDFG, other agencies, and private interests in the watershed. SCWA would work to implement priorities and recommendations formally outlined in the CDFG Draft Basin Restoration Plan for the Russian River Basin (CDFG 2002). Partnerships with other stakeholders in the watershed have been instrumental to the success of SCWA restoration projects and programs. SCWA would expand the indirect beneficial effects of restoration projects by using all available opportunities for public education.

Actions that were implemented prior to the time the MOU was signed (December 31, 1997) are part of the baseline and were outlined in Section 2. Actions proposed or implemented since the MOU signing are part of the proposed project and represent an improvement to baseline conditions. Further details on these actions are provided in the sections below.

3.5.1 WATERSHED MANAGEMENT

SCWA would continue to take a proactive role with regard to restoration and enhancement projects, and stewardship of the watershed. Several specific projects related to SCWA's contributions to watershed management efforts in the Russian River basin are described below.

3.5.1.1 Russian River Symposium

In 1998, SCWA participated in the sponsorship of a three-day Russian River Symposium, at which agencies involved in studies and projects affecting the Russian River presented the results of their efforts. The symposium offered participants the opportunity to gain understanding of current issues in the Russian River, and a chance to build communication, cooperation, and coordination with other entities in the Russian River watershed. Invited participants included landowners, state and federal regulators, city and county planners, decision makers, farmers, activists, members of watershed groups, industry representatives, recreationists, environmental professionals, water and recycled water specialists, public health officials, and teachers and students. The Russian River Symposium is intended to be a one or two-day event occurring every two years.

3.5.1.2 Resource Conservation District Assistance

SCWA has contributed funding for Resource Conservation Districts in the Russian River watershed to develop and implement a Watershed Management Plan. This plan is intended to be a voluntary, watershed-based, locally-driven program to assist the agricultural and grazing community in complying with federal and state endangered species and water quality laws, including the protection of threatened fish species and their habitat. The watershed planning efforts will address soil and water conservation, including the improvement of farm irrigation and land drainage; erosion control and flood prevention; and coordination with community watershed groups. The plan will conform with city and county general plans that are applicable to the Russian River watershed area. In addition, the plan will incorporate the watershed planning needs identified by NOAA Fisheries in notices associated with the listing of coho salmon, steelhead, and Chinook salmon. For example, the listing notice for coho salmon stated that NOAA Fisheries will work with federal, state, and local agencies, including the California Association of Resource Conservation Districts, to develop and implement planning efforts, and that both technical and financial assistance will be made available to farmers in high-priority watersheds.

One program that SCWA has assisted Sotoyome Resource Conversation District with implementing is the “Fish Friendly Farming” program. This program is a voluntary, incentive-based certification program to address recovery efforts of the listed fish species. A technical advisory committee that consisted of grape growers, vintners, farming organizations, environmental organizations, and government officials worked together to develop a set of BMPs aimed at restoring and enhancing the fish habitat in the Russian River watershed. The BMPs focus on conserving soil and restoring and sustaining fish habitat on agricultural property. Participants in the program use a workbook to evaluate and assess their property, current growing practices, and to create a conservation plan for their property. NMFS, CDFG, and RWQCB review the plan and the site, and the grower can receive certification as a “fish friendly” grower.

3.5.1.3 North Bay Watershed Association

SCWA is also participating in the North Bay Watershed Association (NBWA), which has been created to bring together government agencies within the San Pablo Bay watershed to discuss issues of common interest and concern. Such issues include Total Maximum Daily Load (TMDL) regulations, ESA compliance, habitat restoration, recycled water use, NPDES permits and studies, pollution prevention, source water protection, public education, and others. The NBWA will be a forum to allow local entities to:

1. Work cooperatively and effectively with other agencies on watershed-based regulations and issues.

2. Explore coordinated efforts on projects in order to leverage limited funding and resources; decreasing their costs and increasing the effects of projects.

3. Maximize success in securing state and federal grant funding for new watershed initiative programs.

4. Efficiently share information about projects, regulations, and technical issues.

The NBWA can serve as a forum to find ways to increase the effectiveness of habitat restoration projects implemented by the participants. A watershed group, such as the NBWA, can seek opportunities to jointly develop habitat restoration projects to reduce costs and increase the ecological benefits to areas important to listed species.

3.5.1.4 Russian River Watershed Council

SCWA has also contributed to a watershed community council within the Russian River watershed region that has been established by the California Resources Agency and USACE. SCWA has provided a meeting place and refreshments, staff time, and other miscellaneous contributions, and has published updates in the *Russian River Bulletin*. The mission of the Russian River Watershed Council is to protect, restore, and enhance the environmental and economic values of the watershed.

3.5.1.5 KRIS/GIS Database

SCWA is contributing to the North Coast Watershed Assessment Program (NCWAP) by developing Klamath Resource Information System (KRIS) coverages and developing selected Geographical Information System (GIS) layers for several watersheds on the North Coast, including the Russian River watershed. This KRIS/GIS system will develop management tools for NOAA Fisheries and CDFG that facilitate salmon and steelhead conservation and recovery planning in NOAA Fisheries' North-Central California Coast Recovery Planning Domain (planning domain).

KRIS is a Windows©-based or Internet-based computer program that allows easy access to data tables, charts, photographs, and bibliographic materials relevant to fisheries, water quality, and watershed management. The KRIS system can be adapted to any watershed to track factors that affect fish production and water quality over time and across watershed locations. ArcView GIS projects are an integral part of the KRIS program. GIS provides spatially referenced information that is displayed graphically and can be overlaid in conjunction with other spatial or temporal information. GIS "layers" are used in KRIS to develop overlays and facilitate analysis of factors potentially limiting salmon and steelhead conservation and recovery.

The North Bay KRIS/GIS will provide an organized and easily-accessible computer-based collection of technical information that can be utilized by NOAA Fisheries and CDFG as well as other groups working in the region to assist in the definition, implementation, monitoring, evaluation, and adaptive management of measures intended to increase the numbers of naturally reproducing salmon and steelhead in the planning domain. The project will incorporate existing GIS data layers pertinent to salmon and steelhead recovery as well as develop new layers to augment the recovery planning process. Existing digital and non-digital databases, relevant watershed literature, and bibliographic reviews will be reviewed and compiled to identify pertinent data that need to be digitized and/or incorporated into the KRIS information management tools. Data layers identified as necessary for evaluating salmon and steelhead restoration, conservation, and recovery planning efforts will be digitized and incorporated into the KRIS projects based on priorities established by CDFG, NOAA Fisheries, RWQCB, and other applicable state and local organizations in the planning domain. The project will be coordinated with other ongoing GIS and KRIS efforts in the planning domain to avoid duplication of effort.

SCWA is providing funding for the KRIS/GIS project, while the RWQCB will be responsible for managing the program in coordination with California Resources Agency watershed assessment methods and needs. By filling the gaps in drainage coverage and developing a unified platform for data review, analysis, and manipulation, consistent with other similar projects in northern California, the North Bay KRIS/GIS will facilitate salmon and steelhead conservation and recovery planning by NOAA Fisheries and CDFG.

3.5.1.6 Restoration Project Database

SCWA is funding a project for the RWQCB to develop a database of potential restoration projects in the Russian River watershed. The database is intended to identify specific projects that will enhance the quality of surface waters within the Russian River watershed to benefit listed and unlisted aquatic and terrestrial species.

In cooperation with local agencies, watershed groups, and stakeholders, including but not limited to CDFG and the Sotoyome Resource Conservation District, the RWQCB determines what mitigation, enhancement, or water quality improvement projects are currently being proposed, are under development, or may be needed to increase recovery and protection of the listed and unlisted species in the Russian River watershed. The RWQCB inventories and prioritizes these projects in the *Russian River Watershed Restoration Potential Projects Database* for use by local agencies in determining which projects will protect and speed the recovery of the species. Development of this database will aid in coordinating project implementation on a watershed or sub-watershed basis, with the goal of improving water quality and habitat conditions in the most timely and efficient manner. RWQCB began development of this database in 1999. The database is intended to be functional and updateable for all users.

3.5.1.7 Invasive Plant Species Management

SCWA has funded studies to evaluate the status and control of invasive plant species in the Russian River watershed. These studies will inform other projects and assist with watershed-level planning efforts to control invasive species. In 1998, SCWA funded the initial phases of research into the spread of these exotics. To expand the research, Circuit Rider Productions Inc. (CRP) and Sonoma State University will continue ongoing experiments and initiate new investigations. SCWA's Invasive Plants Species study has focused on the exotic plants *Arundo donax* (giant reed), which has been spreading rapidly and are threatening the integrity of the Russian River's native riparian community.

When nonnative plant species replace native species, the riparian ecosystem that salmonids depend on can be altered. The purpose of the Invasive Plant Species Study is to: 1) determine the influence of the exotic plant species, *Arundo donax*, on the composition of native riparian vegetation and invertebrates along the Russian River; 2) evaluate the response of aquatic insects to native and nonnative plant litter deposited in the mainstem and tributaries; 3) identify the most effective methods for eradicating *Arundo*; 4) develop techniques for restoring vegetation in previously invaded riparian areas; 5) map the distribution of *Arundo* in tributary streams; 6) educate the public about *Arundo* and coordinate and train volunteers for *Arundo* removal and follow-up restoration projects. SCWA contributed $58,000 in labor and materials to this project.

The control and restoration of areas invaded by *Arundo* were the focus of two projects. In the Alexander Valley, *Arundo* was removed from test plots by herbicide and mechanical methods, and these experimental trials indicate that herbicide and tarping are highly effective control methods. The recovery of exotic and native plants within the plots was evaluated and showed that removal of *Arundo* allows rapid natural regeneration of invaded sites. In another location, the success of revegetation techniques after *Arundo* removal was evaluated. Exotic plant species influence on invertebrate population abundance was assessed. A UC Berkeley study found a significant preference by aquatic insects for native vegetation, suggesting the food chain for higher animals is altered in *Arundo*-dominated areas.

In 1998, SCWA funded CRP and Sonoma State University efforts to map the extent of *Arundo* along the mainstem Russian River. The 1999 project extended the mapping effort to the Russian River tributaries. The extent of the *Arundo* infestation was delineated using standard aerial photographs and ground-truthing (surveys on the ground) techniques. Information collected during these surveys were entered into a computer database (ArcView GIS software) to generate high-quality maps illustrating the extent of *Arundo* along salmonid-bearing tributaries. This basin-wide mapping and GIS program was completed in fall 2001. The program will track *Arundo* populations, prioritize sites for restoration, and monitor project success. CRP has provided workshops and technical sessions to local communities, landowners, and environmental groups on appropriate techniques for restoring native riparian habitat in areas where *Arundo* has been removed.

3.5.1.8 Federal and State Recovery Planning

The ESA requires development of a recovery plan for listed species. NOAA Fisheries is charged with developing a recovery plan for the Northern California Recovery domain. In north-central California, NOAA Fisheries, CDFG, and local agencies collaborate to provide NOAA Fisheries with support and assistance in fulfilling federal obligations to develop recovery plans. SCWA is providing staff support for the development of an MOU for this effort and is ready to assist as necessary.

CDFG conducts recovery planning for the state coho salmon listing under the California ESA. The State of California initiated a recovery planning process for coho salmon north of San Francisco Bay and expects to complete the plan by October 2003. SCWA is providing financial and staff support for this effort. SCWA provides support to the State of California to provide a facilitator and technical assistance. SCWA also sits on the Recovery Team. SCWA is providing support to CDFG, the Bodega Marine Lab (BML) and other agencies and organizations in developing a framework for state recovery planning efforts that will facilitate and complement the federal recovery planning effort.

3.5.2 Riparian and Aquatic Habitat Protection, Restoration, and Enhancement

SCWA began implementation of the FEP in 1996. Since 1996, SCWA has granted funds to various entities each year to provide habitat restoration and research on listed fish species in the Russian River watershed.

In addition to the FEP projects, SCWA has provided funding and staff for research that will facilitate restoration and protection of listed fish species in the Russian River. An important example is SCWA's funding of a project for BML to conduct genetic studies of tissue samples from coho salmon captured in the Russian River watershed. These studies have been used to identify the closest relation of the Russian River salmonids to known population stocks of coho and Chinook salmon. They are being used to help design the coho salmon captive broodstock program at the DCFH. These studies may also be used for genetic analyses of adult salmonids returning to the hatcheries at WSD and CVD.

SCWA has provided funding and production support for the publication and distribution of a native riparian plant handbook to assist landowners, schools, and community groups with native plant revegetation projects within the Russian River watershed. These efforts reduce streambank erosion and reduce the risk of exotic, invasive plant species being introduced to the riparian habitat. SCWA has provided staff and materials to conduct parcel ownership research in the Russian River watershed to provide the CDFG and SCWA with contact information for landowners to contact to gain stream access for habitat surveys and water quality data collection.

Several specific projects designed to benefit coho salmon, steelhead, and Chinook salmon are described below. In addition to these specific projects, SCWA has funded and/or implemented numerous projects that indirectly benefit coho salmon, steelhead, and Chinook salmon. For example, SCWA has provided funding, staff, and equipment for ongoing clean-up efforts on the Russian River and its tributaries. Those efforts have resulted in the removal of garbage and other materials that could have degraded water quality and habitat quality. These clean-up efforts have also increased community participation in restoration of the Russian River.

A Contingency Fund has been established to provide a source of expertise and materials for small projects not included in the current FEP. There are a large variety of small non-profit groups implementing effective fishery restoration projects in Sonoma County. This fund allows SCWA to provide assistance on a relatively short time frame. The cost of most of these projects is low. For example, SCWA provided $4,535 to fund a five-year program to teach elementary students about steelhead lifecycle and habitat needs. SCWA funded a restoration project that enhanced 2,500 feet of Austin Creek by installing five boulder wing deflectors, seven log/root wad structures, three willow baffles, and native plants. SCWA funded revision and reprinting of CRP's *Riparian Habitat Guide*.

3.5.2.1 Stream Habitat Surveys

Stream habitat surveys have been conducted in cooperation with CDFG each year of the FEP since 1996, and are intended to assess the habitat conditions of streams that are potentially viable for salmonid production. The goal for this project is to conduct habitat surveys on every stream within the Russian River watershed. All data gathered are entered into CDFG's computer program to prioritize stream restoration projects. These data are available for integration into the KRIS/GIS database. SCWA has allocated staff and materials for this project.

3.5.2.2 Temperature Data Collection

Water temperature monitoring has been conducted each year of the FEP since 1996 to identify streams that provide suitable summer thermal conditions for salmonid juvenile rearing. Because environmental conditions vary annually, an accurate depiction of stream temperature requires data collection in multiple years. Data loggers (i.e., equipment to monitor and record water quality measurements at specific intervals) are removed annually from each stream during the fall and deployed again the following spring. Temperature data have been collected in the Mark West, Maacama, Austin, East Austin, Santa Rosa, Dutch Bill, Hulbert, Dry, Brush, Matanzas, and Big Sulphur creek watersheds. SCWA has allocated staff and equipment for this project. For example, SCWA installed approximately 50 water temperature data loggers in spring 2001. Water temperature data were also collected in the summer and fall of 2002 during a steelhead distribution study (Cook 2003).

In 2000, SCWA began coordinating its temperature monitoring efforts with the RWQCB and other entities, conducting water quality monitoring in the Russian River watershed, including the City of Santa Rosa, and Mendocino County. These groups met several times to coordinate placement of temperature monitoring equipment, standardization of techniques, sharing of equipment, and exchange of information. Mendocino County compiles all of the temperature data into a single database. This coordination will allow for more effective monitoring of temperatures in the basin by applying the collective efforts in a more efficient manner, as well as allowing for better comparison of results through standardization of techniques and reporting formats.

3.5.2.3 Water Quality Sampling

This project includes collecting and identifying invertebrates from several streams in the Russian River watershed and analyzing the samples as indicators of water quality. Analysis of the data has entailed sampling of reference streams identified by CDFG for a minimum of two years to establish a baseline reference condition. Other streams sampled are compared to those reference streams to determine relative water quality status. This project has been implemented each year since 1996. SCWA contributes staff and materials for the project. Additionally, SCWA provided funding for analysis of samples. Streams assessed include Austin Creek tributaries, Maacama Creek tributaries, the Russian River mainstem, Mark West, Santa Rosa, Green Valley, Mill, Ackerman, Robinson, Dutch Bill, Hulbert, Fife, Franz, Porter, and Redwood creeks.

3.5.2.4 Russian River Basin Coho Salmon and Steelhead Population Monitoring

Coho salmon and steelhead populations in the Russian River basin have decreased over the last 100 years. However, comprehensive population surveys have never been conducted in the basin, making it difficult to document the decline or accurately track recent population trends. In conjunction with NOAA Fisheries and CDFG, SCWA is planning a basin-wide monitoring program to determine long-term trends in salmonid abundance. Streams throughout the watershed would be sampled annually using a variety of methods including direct observation (snorkeling), trapping, and electrofishing. While the program would generate indices of abundance for all salmonid life stages (e.g., juveniles, smolts, and adults), SCWA would focus primarily on obtaining population estimates for juveniles during late summer and fall. Consistent environmental conditions during this portion of the year allow access to a large number of sites and increase the repeatability of annual surveys.

SCWA funded a project to develop a study plan for the population monitoring project. Following the second year of the pilot study, SCWA adopted a final plan in consultation with NOAA Fisheries and CDFG and has completed the first three years of a pilot study to evaluate methods and sampling sites in the field. During the second year of this project, electrofishing and/or snorkel surveys were conducted in three tributaries of the Russian River, including 68 sites in Santa Rosa Creek, 66 sites in Mark West Creek, 20 sites in Millington Creek, and 122 sites in Sheephouse Creek. Protocols developed after the first two years of the study would be used for this project as well as other FEP projects requiring fish surveys. The focus of this project is currently being reevaluated and the objectives of future population studies will likely change to meet the needs of SCWA and cooperating entities.

3.5.2.5 Instream Habitat Improvements

SCWA has funded and/or implemented projects since 1996 to improve habitat in stream channels. Streams were identified as candidates for instream habitat improvements, including Mill, Austin, Turtle, Felta, Green Valley, and Dutch Bill creeks. Instream habitat structures that have been placed consisted of large woody debris, such as rootwads, that provide protective cover from predators and that promote development of pools. Sites lacking in riparian cover have been planted with trees. A section of Big Austin Creek was reconstructed to convert a braided, intermittent channel to a single thread, perennial stream, with 13,000 square feet of reconstructed spawning area. Additionally, bank stabilization and riparian planting were implemented along Big Austin Creek (see Section 3.5.2.12). SCWA provided matching funds and staff support for these projects. SCWA provided partial funding to install seven large woody debris structures in six pools along Dutch Bill Creek that provide habitat for coho salmon.

Green Valley Creek is one of the few tributaries in the Russian River watershed that still supports a self-sustaining, although diminished, population of naturally spawning coho salmon. Surveys conducted by CDFG showed that Green Valley Creek lacked pool habitat and cover. Completed in 2002, the Green Valley Creek Restoration (Site 1) project increased the amount of pool habitat in the creek by installing four large instream woody debris structures. These structures were in good condition after the winter floodwaters of 2000/2001 and a CDFG biologist observed coho salmon at the enhanced pool. The endangered California freshwater shrimp also occurs at the pool. A restoration project at the Green Valley Creek Restoration (Site 2) included recontouring an eroded bank, installing a willow mattress, and planting 35 native riparian trees, thereby stabilizing and restoring 30 feet of eroding bank. This project was completed in 2002. The Green Valley Creek Restoration (Site 3) project stabilized an eroding bank by constructing a small berm at the base of a drainage swale and recontouring the bank to stabilize the soil. Two wood structures were installed in the creek to enhance pool habitat for salmonids. Approximately five native riparian plants were planted in fall 2001. Both of these projects reduced sediment input to the creek. These two projects were partially funded by SCWA.

3.5.2.6 Riparian Restoration

SCWA has funded and/or implemented projects on Howell and Turtle creeks to exclude livestock from the riparian zone adjacent to the stream, and to replant degraded areas with native vegetation. These projects allow riparian vegetation to re-establish, stabilize streambanks, and decrease animal waste entering the stream. SCWA has provided funding, staff, and materials for these projects. In areas where vegetation has been removed, native trees will be planted to provide vegetative cover for wildlife, and shade and structure for aquatic biota.

The Lytton Creek Riparian Restoration and Education project restored 15 acres of native riparian habitat along a salmonid-bearing tributary to the Russian River. The project restored a degraded riparian zone and converted four acres of vineyard back to riparian. In the winter and spring of 2001, 1,200 plants were installed with a 90 percent survival rate in early July of the same year. Restoration effects will be monitored for a five-year period. The project included an environmental education program that incorporated high school students, landowners, and the community in the planning, design, implementation, and monitoring of the project. This project provided an important opportunity to demonstrate that healthy natural ecosystems can coexist with viable farming practices. CRP and Clos du Bois winery implemented the project and SCWA provided $27,936 in matching and in-kind funds.

SCWA provided funding for a study to investigate methods of controlling Pierce’s Disease through removal of nonnative plants that are serving as sharpshooter hosts while maintaining a viable riparian community. The disease attacks cultivated grapes and is transmitted by insects (e.g., sharpshooters). Vegetation on Maacama Creek was removed using hand labor and herbicides. Native trees were planted to provide vegetative cover and to provide habitat for birds, small mammals, as well as to provide shade and recruitment of woody debris into the creek for fish. Removal of targeted riparian understory was completed in 1999 to 2000. Researchers from UC Berkeley conducted insect monitoring for three years. Insect trapping found a 50 percent reduction in sharpshooters in riparian-managed areas compared with undisturbed riparian areas. The reduction in sharpshooters was 70 to 99 percent at two other study sites located in Napa Valley. This project demonstrated that selective removal of vegetation can control an insect vector of Pierce's disease while maintaining riparian habitat.

3.5.2.7 Rural Road Erosion Control Project

SCWA provided funding and materials for a project to decrease sediment runoff from one mile of steeply graded rural roadway adjacent to Palmer Creek. The project consisted of measures to reshape, grade, and excavate runoff ditches in the existing roadway and resurface it with high-quality crushed blue shale. Undersized culverts were replaced to minimize erosion. A series of rolling dips was graded into the roadbed in an effort to properly drain the road and reduce erosion during heavy rains. In addition, decreasing the sediment load enhanced instream habitat structures, also funded by SCWA, on the same stretch of Palmer Creek. The project was completed in 2001.

3.5.2.8 Hood Mountain Regional Park

This project was implemented to reduce delivery of fine sediment to Santa Rosa Creek from an eroding road adjacent to the stream. The portion of Santa Rosa Creek within Hood Mountain Regional Park provides valuable spawning and rearing habitat for steelhead. During the winter of 1996-97, a landslide on Hood Mountain Trail, adjacent to Santa Rosa Creek, displaced over 300 cubic yards of material. In 1999, the site remained unstable and continued to deliver fine sediment to the stream. SCWA granted FEP funds to Sonoma County Regional Parks in 1998 for the development of engineering plans to stabilize the slide. The project was implemented during the 1999-2000 FEP and provided a comprehensive repair to the cut slope, modified the road surface, and filled gullies.

During 1998 through 2001, SCWA provided staff support, materials, and funding for other components of the Hood Mountain project, including: regrading a road crossing and adding rock baffles to improve fish passage; removal of litter (e.g., chain link fence, 55-gallon drums); and development of a water quality monitoring program to be run by LandPaths staff and local high school students.

3.5.2.9 Brush Creek

This project was designed to maintain the flood conveyance capacity of Brush Creek while improving aquatic and riparian habitats. The completed project enhances available habitat for steelhead and other native fish, amphibians, songbirds, and small mammals along Brush Creek. Brush Creek previously underwent channel modifications to allow conveyance of 100-year flow events and provide flood protection for local homeowners. The project widened the cross-sectional area of Brush Creek to permit the stream to both convey streamflow during a 100-year flood event and provide the area necessary to increase habitat diversity along 1,200 lf of the stream. Overall, approximately 4,500 cubic yards of material was removed from the streambed and banks. After the streambed and banks were graded, a series of restoration and enhancement activities were instituted to provide aquatic and riparian habitat throughout the project area. A meandering low-flow channel was constructed in the streambed. Instream structures such as weirs, deflectors, and suitable substrate material were placed in the river to promote the development of pool and riffle habitats, as well as providing bank stability. Stream banks denuded of vegetation during the sediment removal and grading phase of the project were replanted with native vegetation. SCWA contributed $40,000 of funding to the $287,000 project.

3.5.2.10 Copeland Creek

This project involved construction of cattle exclosure and monument fencing, recontouring heavily eroded streambanks, and revegetation with native riparian species on Copeland Creek. The project site is located on approximately 6,000 feet of Copeland Creek between Roberts/Pressley Road and Petaluma Hill Road. Historically, the project site has been grazed by cattle and horses. Grazing pressures limited vegetation establishment to nonnative grasses and forbs, with tree cover limited to a stand of nonnative Eucalyptus, some scattered oaks (*Quercus* sp.), and California buckeye (*Aesculus californicus*). Numerous cattle paths crossed the channel, and trampling exacerbated erosion of the banks. Restoration of this section of stream decreased sediment load and improved fish habitat. Fencing was installed to prevent livestock access to the riparian zone. Banks were recontoured to a more stable profile. Riparian vegetation was reestablished along the streambanks to provide stability and shade. This project began in 1999 and implementation was phased over several years. Restoration of the final 1,000 feet of degraded creek will be completed by the end of 2003. Monitoring of fish, wildlife, and habitat began in winter 2001 and is scheduled for at least five years. SCWA provided staff support, materials, and funding for this project.

3.5.2.11 Howell Creek Livestock Exclusion Fencing and Riparian Enhancement

This project excludes cattle from the riparian zone along 4,000 feet of Howell Creek, a tributary of the Russian River, in Mendocino County. A 1998 stream inventory conducted by CDFG indicated that riparian vegetation and stream channel conditions were degraded due to unrestricted cattle grazing in this reach of Howell Creek. This section of stream provided only marginal habitat for steelhead. Healthy riparian vegetation is necessary to improve the condition of the streambanks and bed in this reach. Barbed wire fence was installed and off-stream water sources were developed to eliminate the intrusion of cattle into the riparian zone. Native riparian vegetation was planted in the project site to facilitate recovery. SCWA is providing $14,232 in funding for this project.

3.5.2.12 Big Austin Creek

This project reconstructed 1,300 feet of braided, intermittent channel to a single-thread channel, perennial stream with 13,000 square feet of reconstructed spawning area. The project also included bank stabilization and riparian vegetation planting along sections of the stream channel. Prior to the project, a series of shifting channels flowed through an area known as “King’s Flat.” Large amounts of bedload from old mining tailings located upstream of the project area caused excessive aggradation, resulting in a braided multichannel stream. By restoring the stream to a single channel, fish habitat is greatly improved. Stream sections with highly eroded banks were stabilized with rock, rootwads, and live trees. Riparian vegetation was re-established along the banks to increase cover and help reduce water temperature. Work completed under the 1997 to 1998 FEP Plan included bank stabilization, placement of instream cover, and construction of willow baffles. Work conducted under the 1999 to 2000 FEP Plan included additional stream bank stabilization and riparian vegetation planting. The site has stabilized naturally and a weir originally planned for the site is not needed. Restoration is considered complete and monitoring is scheduled through 2002 to 2003.

3.5.2.13 Russell Irrigation Site on Turtle Creek

The purpose of this project was to facilitate development of a mature riparian forest, stable stream banks, and improved aquatic and terrestrial habitats. This was accomplished through providing an alternative drinking source for livestock that previously used the stream as a watering source. The landowner for this site previously participated in a voluntary fencing project to exclude the cattle from Turtle Creek. To provide the alternative drinking source for the livestock, a well was removed and repaired, and 2,100 feet of pipe were installed to deliver the water to the cattle. SCWA provided the funding for this project.

3.5.2.14 Mumford Dam Fish Passage and Riparian Restoration

Mumford Dam is a medium-size diversion dam (approximately 60 feet wide and 8 feet high) located on the west branch of the Russian River near the town of Redwood Valley. This project will improve fish passage over Mumford Dam and improve streambank stability and riparian habitat near the dam.

Since its construction in the early 1900s, the streambed below the dam has down cut between 8 to 15 feet. This down cutting has virtually eliminated fish passage over the structure, restricting access to approximately 50 miles of spawning habitat. In addition, down cutting has caused massive erosion and bank failure for approximately 600 feet below the dam.

The project involves recontouring the streambanks to a more stable profile, constructing a series of weirs to facilitate fish passage, and revegetation with native plants. The dam owner will also upgrade the diversion facilities to comply with NOAA Fisheries fish screening criteria. SCWA provided $60,000 in 2000 to 2001 to assist with design and permitting expenses. SCWA assisted the Simon Partnership (landowners) with engineering design plans, conducted botanical, fish, and wildlife surveys needed for the environmental permitting, and acquired needed permits. Construction of the project was implemented in the summer of 2002 and revegetation was implemented in the fall of 2002.

3.5.2.15 Laguna de Santa Rosa

USACE is conducting a feasibility study to investigate the extent and causes of sedimentation in the Laguna de Santa Rosa (Laguna). The Laguna area is a large, gently sloping basin with natural flood retention capability and historic wetland attributes. Historically, it served as a major storm retention basin during periods of flooding. Human development has modified hydraulic and hydrologic conditions in the surrounding area and may be accelerating habitat changes in the Laguna. Siltation from municipal development in the surrounding area and from certain agricultural practices may be reducing the Laguna's attributes and flood-retention capability.

The Laguna drains a basin of 250 square miles (160,000 acres) that includes the adjacent cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol. The Laguna transports rainfall runoff from the watershed to the Russian River, and as the WSE in the Russian River rises with increasing runoff flows, water flows back into the Laguna from the Russian River. The Laguna is considered to be an important factor in lowering the WSE in the lower Russian River floodplain.

The results of the initial sedimentation studies will determine which, if any, alternatives are investigated for the possibility of management and restoration measures. The measures to reduce adverse effects of sedimentation on flood control capacity and habitat could include the following:

1. Watershed management measures: identify sediment reduction alternatives; conduct a topographic survey of the Laguna to use as a comparison to past data and as a baseline for future studies; inventory stream channels; analyze air photos; and use historic and current information to determine local sources of sediment affecting the Laguna.

2. Channel restoration measures: identify and characterize flood control channels within the Laguna; identify and evaluate structural flood detention alternatives; identify and evaluate flood protection within the Laguna.

3. Habitat restoration measures: identify and characterize opportunities to restore historic wetlands for optimum diversity and long-term sustainability.

3.5.2.16 Santa Rosa Creek

USACE, SCWA, City of Santa Rosa, and Sonoma County are undertaking a project to restore Santa Rosa Creek by returning the channelized creek reaches to a more natural geomorphic and ecological form and function and improving water quality, while maintaining existing levels of flood protection. The restoration is also intended to benefit steelhead and other aquatic life. The project is consistent with the Santa Rosa Creek Master Plan, which was signed on September 21, 1993 by the City of Santa Rosa, the County of Sonoma, and the Sonoma County Water Agency.

Initially, the City of Santa Rosa (the non-federal sponsor) requested that the USACE conduct an investigation to determine if there was a Federal interest in an ecosystem restoration project along the creek**.** A 1997 Reconnaissance Report that investigated the Russian River and tributaries concluded it was likely that an ecosystem-restoration project would be in the federal interest. This permitted the USACE and the City of Santa Rosa to develop a Project Study Plan and subsequently execute a cost-sharing agreement to initiate the current Santa Rosa Creek Ecosystem and Flood Damage Reduction Study Feasibility Study.

During the initial phase of the study, there was uncertainty about whether the existing flood-control project had adequate capacity for a 100-year-flood event due to floodplain development and environmental changes in local conditions since the project was constructed in the early 1960s. A draft hydrologic analysis, conducted by the USACE in August 2002, concluded that improved and unimproved channels within the watershed would experience flows during a 100-year-storm event significantly greater than anticipated by the original design documents for those facilities. USACE determined that flood-damage reduction was an appropriate purpose under the existing authorization for the Feasibility Study (i.e., the Water Resources Development Act of 1996). Thus, additional tasks were identified and incorporated into the study, now the Santa Rosa Creek Ecosystem and Flood Damage Reduction Study Feasibility Study. The Project Management Plan is scheduled to be complete and signed in June.

In the City of Santa Rosa Master Plan, the 12.8-mile-long project has been divided into seven reaches, distinguished by vegetation, hydrology, adjacent land use, ownership, channel morphology, and access. Reaches A and B, which are between Highway 12 near Los Alamos Road and E Street, are characterized as natural channel. The vegetation represents a mature, native riparian community. This area is in private property ownership with limited access. Commercial, residential, and undeveloped land uses are located adjacent to the creek. Reaches C, D, and E, are between E Street and Piner Creek west of Fulton Road. They are characterized by a relatively steep, trapezoidal-shaped channel with grouted rock in Reach C and riprap in Reaches D and E. There is very little riparian vegetation. SCWA owns the two maintenance roads on either side. Adjacent land use is commercial, residential, and industrial. The Rural Reaches F and G are between Piner Creek and the Laguna. These reaches are characterized by a wider and shallower channel with more sediment bars, less riprap (none in Reach G), and some riparian vegetation. There are levees in Reach F and maintenance roads along both sides of the creek in both reaches. The adjacent land use is agriculture and floodplain. The boundaries of the proposed restoration project include part of Reach C (Pierson Street to Dutten Street) and all of Reach D through Reach G. No action is proposed for Reaches A or B.

The project is currently in the planning and permitting phase. Several alternatives are being considered, which are discussed below. The selected alternatives will be implemented in the project area. The action alternatives include restoring habitat and improving water quality by implementing one or more of the following measures in the various reaches of Santa Rosa Creek:

> *Measure 1:* Enlarge channel capacity by removing existing grouted riprap, replacing the southern bank with a steeper, engineered wall system that will allow for vegetative growth, and by stepping the north bank with a series of retaining

walls that will allow for multiple use, and pedestrian and maintenance paths. A soft, naturalized creek bottom will be vegetated with native riparian grasses, sedges, and shrubs. This restoration measure is proposed for sections of Santa Rosa Creek between Santa Rosa Avenue and Pierson Street.

Measure 2: Enlarge the channel capacity by removing the existing riprap, laying back the southern bank to a more stable angle, and terracing the northern bank to allow for path installation. The newly constructed channel will be vegetated using native riparian species. The creek bottom will provide a soft, meandering low-flow channel, which will be shaded and will feature rocks and anchored logs for fish habitat. This restoration measure is proposed for sections of Santa Rosa Creek between Pierson Street and Piner Creek.

Measure 3: Enlarge channel capacity and expand the existing cross-sectional area of the creek by removing existing riprap, laying back one bank, and excavating the other bank to create vegetated terraces on which paths would be placed. The entire creek channel will be revegetated with native riparian plant materials. This restoration measure is proposed for limited sections of Santa Rosa Creek between Stony Point Road and Piner Creek.

Measure 4: Increase the channel width by relocating one or both levees away from the creek a total of not more than 100 feet. The creek channel would be re-contoured to create a naturalized meander pattern with riparian plantings throughout. This restoration measure is proposed for sections of Santa Rosa Creek between Piner Creek and Willowside Road.

Measure 5: The area of riparian vegetation would be expanded by 100 feet or less between Willowside Road and Laguna de Santa Rosa to enhance the riparian vegetation and to allow the development of a meandering low-flow channel.

In Measures 1 through 5, rocks would be placed in the creek to create pools, riffles, and runs, and define the low-flow channel. In addition, anchored logs with root wads exposed to the creek will be installed. These features will enhance the structural diversity of the channel bottom and improve fish habitat.

3.5.2.17 Dry Creek

Coho salmon spawning gravels are smaller than those used by steelhead or Chinook salmon (Kondolf and Wolman 1993). As discussed in *Interim Report 1*, the high flows in Dry Creek may more readily transport coho salmon gravels out of the upper reach (ENTRIX, Inc. 2000a).

SCWA would construct habitat improvement structures using boulders and redwood or fir trees at suitable locations in Dry Creek to increase habitat complexity and available cover, and provide areas that hold coho salmon spawning gravels. Structures would have to be quite large to remain in place and be effective at trapping coho salmon-sized gravels. The structures would typically consist of three or four, 3- to 5-ton rocks and a tree with attached limbs and root ball. Individual trees would be at least 18 inches in diameter and 35 to 40 feet in length. The structure would resemble a grounded sweeper and debris pile along the channel margin. Debris clusters would be anchored in place by burying the downstream end of the tree and placing a large rock on top of the back-filled excavation. Two large boulders would hold the root ball in place. These structures may require periodic maintenance/modification of the debris to maintain its effectiveness. Initially, root wads or other structures would be placed at intervals of 500 feet, on average, providing approximately 150 structures along a 14-mile length of channel. These would not be placed at even intervals, but rather clustered in areas where geomorphic conditions and access afford the best opportunities.

Large woody debris or other structures placed in the stream channel may reduce channel capacity and increase the risk of flooding and/or bank erosion. Large woody debris may slow or alter currents in a way that could increase the potential for flooding of adjacent land. These instream structures could, in some cases, redirect flows to streambanks and encourage bank erosion. Therefore, placement of large woody debris would require establishment of an expanded riparian zone for flood protection and education of the public regarding the benefits of this action. If structures placed in the stream become mobile, they may cause flooding due to obstruction of flows. The effectiveness of this action is related to the number of locations where it can be implemented. While a larger number of structures would promise greater habitat gains, restricted stream access and the need to obtain permission from landowners may constrain the number of sites where structures could be placed.

SCWA would restore the overflow channels on Dry Creek to provide additional flood capacity, potentially reducing channel incision. This activity would include selectively removing riparian vegetation from the flood (i.e., high-flow) channel of selected portions of Dry Creek, thereby removing obstructions to flow from the high-flow channel. Woody vegetation between the high-flow bank edge and the edge of the low-flow channel would be removed. A band of riparian vegetation along the low-flow channel would be left intact. Some recontouring may be required to connect the high-flow channels with the main channel. The width of the vegetation band would be determined on a reach-by-reach basis to ensure that sufficient vegetation is left to shade the low-flow channel and ensure stability of the vegetation. Site-specific conditions would be evaluated to ensure floodplain continuity and habitat connectivity.

The high-flow channels would carry water during flood flows. The channels would be recontoured, as necessary, to drain back to the main channel as flows recede. The slope and gradient of the high-flow channels would be adjusted to reduce the potential for young fish to become trapped or stranded when the channels dewater. The construction of high-flow channels may require some additional site grading and bank contouring to reconnect the main and high-flow channels. This construction activity would take place during the low-flow period to minimize the opportunity for sediment to reach the active channel. Heavy equipment would be used following construction BMPs, which would reduce the risk to young fish and minimize habitat disruption. Periodic maintenance of high-flow channels may be required to prevent vegetation encroachment. Overflow channels may require more space along Dry Creek than is currently available. Purchase of conservation easements would be required to fully implement this action.

3.5.2.18 Gold Ridge Stewardship Program

The Gold Ridge Stewardship Program enhances fisheries habitat and water quality through coordination of watershed restoration and stewardship efforts. The Gold Ridge RCD promotes the formation of watershed groups for community members through education, outreach, and identifying priority watershed issues. SCWA provided matching and in-kind funds. In 2000-2001 the stewardship program published two newsletters and hosted a rural roads workshop. The rural roads workshop was presented by Pacific Coast Watershed Associates and discussed proper installation and maintenance of private dirt roads to minimize erosion and runoff into streams.

The Gold Ridge RCD organized clean-ups in the Green Valley and Dutch Bill Creek watersheds with local watershed groups, schools, and other local groups and agencies. The purpose of the Gold Ridge Creek Clean-ups is to minimize pollution and obstructions to fish passage, improve creek aesthetics, and distribute educational materials. The clean-ups are supplemented by the distribution of educational materials to landowners regarding the effects of pollution on fisheries and water quality.

3.5.2.19 Riverfront Park Reclamation

SCWA and the Sonoma County Agricultural Preservation and Open Space District (Open Space District) together purchased property from Hanson Aggregates Mid-Pacific, Inc. The 304.62-acre property will be used for preservation of open space, a public park, and for water education purposes. The SCWA Riverfront Park property is located adjacent to the Russian River in north-central Sonoma County at 7821 Eastside Road. Located on the floodplain terrace of the Middle reach of the Russian River, the property was used for terrace-pit gravel mining (Figure 3-1). Three pits have filled with water and are now referred to as Lake Benoist (67 acres), Lake Wilson (37 acres), and Lake McLaughlin (23 acres). The property also contains a pad (the McLaughlin Pad), which was the site of gravel processing operations. As part of the mining operations, the topsoil was previously stripped from the McLaughlin Pad and stockpiled on-site for future reclamation purposes.

There is a potential for salmonids to be entrained in these lakes when water levels recede after high-flow events. There are levees on the riverbank next to the property, but flood water can flow through an opening in the riverbank at the Doyle Pit located to the north of Lake McLaughlin (Figure 3-1) and flood adjacent property. Flow can enter Lake McLaughlin at several locations through the berm at the north end of the lake. Floodwaters can also flow from the northwest when the river overtops the banks. Water also flows to Lake Benoist through a rock riprap weir at the southern end of the lake, and floodwaters can back up into Lake Wilson and Lake McLaughlin. At high-flood flows, the entire area can be under water.

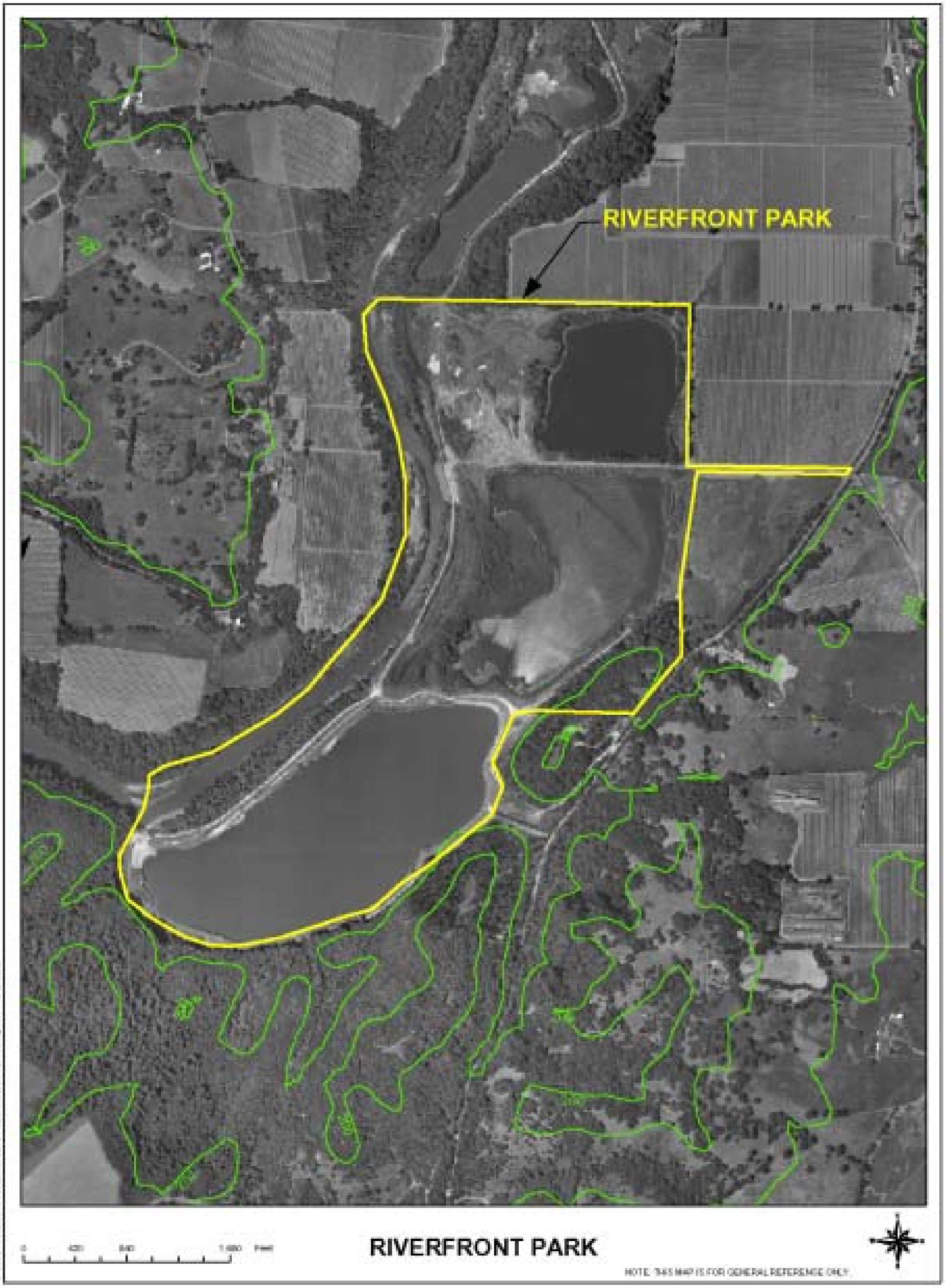

Figure 3-1 Riverfront Park Area Map

River water that crests the bank at the Doyle Pit and flows into Lake McLaughlin provides a potential conduit for fish passage. A berm with an average elevation of about 71 feet on the north side of the McLaughlin site prevents floodwater from flowing directly into Lake McLaughlin from the north. However, floodwaters, as well as overland flow, can flow through culverts through the berm. Flow from the property to the north (particularly from the terrace at two locations in the vicinity of the Hopkins and Doyle pits) can flow through two eight-foot culverts located on the northeast corner of the lake, and through a three-foot culvert on the northwest corner of the lake that drains approximately five acres of vineyard.

Aerial topography and field inspection show that the two eight-foot culverts drain about 23 acres, and the remainder drains through a vineyard swale into the Doyle pit (Murray, Burns, and Kienlen 1999). Water can flow through a low area adjacent to the Doyle Pit located at the northeast corner of Lake McLaughlin. When the terrace near the Hopkins and Doyle pits to the north of Lake McLaughlin reaches a flood stage of 63.5 feet (1.75-year return interval or 28,000 cfs at Healdsburg), flow is directed through two swales toward the McLaughlin culverts.

Floodwater from the river flows through the weir at Lake Benoist. The top of the weir is at an elevation of approximately 53.0 feet, and fish passage can only occur when water flows over it. When Lake Benoist is full, water flows into Lake Wilson over the land bridge between the lakes. An abandoned haul road embankment separates McLaughlin and Wilson lakes. Water flows into Lake McLaughlin when flood waters overtop the lowest perimeter elevation between the Lake McLaughlin and Lake Wilson banks, which is approximately 60.5 feet (NGVD) at the southwest corner of Lake McLaughlin (1.25 return interval).

Hydraulic analysis at the site indicates that the riverbank at Lake McLaughlin can be expected to overtop at approximately a two-year average return interval. The lake and surrounding landscape are completely inundated at an elevation of 71 feet (generally a ten-year flood event).

When flood flows recede, Lake McLaughlin drains into Lake Wilson. All three lakes eventually drain back to the Russian River through the weir in Lake Benoist and via ground percolation. During the summer, Lake Benoist is the deepest of the three lakes with a depth of over 50 feet.

SCWA is preparing plans for reclamation of the property to return the site back to wildlife habitat consistent with the intent of the site-specific 1995 Master Reclamation Plan. The reclamation work would include surface regrading and replacement of topsoil over the McLaughlin Pad, repair of erosion damage at the two-way spillways between the lakes, construction of the levee closure between McLaughlin and Wilson lakes along the Russian River, and installation of native vegetation to create wildlife habitat on the site. Reclamation work will be coordinated with Sonoma County Regional Parks Department’s plans to incorporate initial trails and enhance access to portions of the property. Contract drawings for a reclamation construction project would be prepared in 2004 with construction scheduled for completion by the end of 2004.

3.5.2.20 Best Management Practices for Restoration Projects

BMPs used are site-specific, but in general, SCWA follows the procedures outlined in the CDFG Fisheries Habitat Restoration Program. With few exceptions, SCWA projects are not built on "live" streams. Most can be constructed during a period when the stream is dry. In most cases, if not all, work in a wet stream channel would require a permit from USACE, and the terms and conditions of that permit would dictate the practices used to minimize effects. For example, on Austin Creek reconstruction of the toe of the bank was necessary, and the BMPs used were those stipulated by the USACE permit. A combination of detention basins, hay bales, and filter fabrics were used, and no sediment problems were identified. On Adobe Creek (not in the Russian River Basin), SCWA built a fish passage (with a series of boulders) in an active stream, and fish rescues were conducted to move as many fish as possible out of the project area.

SCWA strives to avoid any effects to the streams or listed species while implementing restoration projects. Details for specific projects to be constructed have been provided where they are known.

Table 3-8 summarizes information about actions that are part of the proposed actions and, where known, indicates the listed fish species the action is likely to affect. Steelhead are the most abundant species in many of these areas, but as coho or Chinook salmon populations are recovered, utilization of these streams by these species is likely to increase. All projects listed are likely to improve habitat for spawning, rearing, and migration of listed salmonids. Restoration actions that are part of the proposed actions and have been implemented since the time the MOU was signed represent an improvement to baseline conditions and do not require a take authorization. Actions that require take are projects that will be implemented and may have direct effects on listed species during construction. They are usually projects that require instream work while listed fish species may be present. BMPs to minimize adverse effects are generally outlined during the permitting process.

Table 3-8 Summary of Restoration and Conservation Actions that are Part of the Proposed Actions

The size of the project is the actual length of stream affected. A "+" indicates projects that have effects that may extend well beyond the immediate project area.

Creek	Type of Project	Size of Project	Species Affected[1]
PART OF THE PROPOSED ACTIONS (NO TAKE STATEMENT REQUIRED)			
Instream Habitat Improvements			
Dutch Bill	7 habitat structures	6 pools	Co, St
Mill	14 sets instream habitat structures	~ 2 miles	St
Felta	14 sets instream habitat structures	~ 2 miles	Co, St
Green Valley	Four instream habitat structures		Co, St
Riparian Restoration			
Copeland	Fencing, grading, riparian planting	6,000 ft	St

Table 3-8 Summary of Restoration and Conservation Actions that are Part of the Proposed Actions (Continued)

The size of the project is the actual length of stream affected. A "+" indicates projects that have effects that may extend well beyond the immediate project area.

Creek	Type of Project	Size of Project	Species Affected[1]
Green Valley	Erosion control and riparian planting		Co, St
Howell	Fencing	4,000 ft	St
Lytton	Riparian planting with environmental education	14 acres	St
Turtle	Willow walls & mattresses	500 ft	Co, St
Turtle	Irrigation	> 1 mile	Co, St
Felta	Willow walls	3 projects	St
Russell Irrigation site on Turtle Creek	Fencing, cattle removal	> 1 mile	Co, St
Unnamed - Huff property	Willow wall		Co, St
Instream and Riparian Restoration			
Austin	5 boulder wing deflectors, 7 log/root wad structures, 3 willow baffles, native plants	2,500	St
Brush	Streambed and bank regrading, instream structures, revegetation	1,200 ft +	St
Big Austin	Reconstruct channel	1,300 ft	Co, St
Big Austin	13 erosion control/riparian structures – willow baffles, willow wall, slide repair	0.5 mi. +	Co, St
Green Valley	Erosion control, revegetation, two instream habitat structures		Co, St
Palmer	Instream habitat structures	3,000 ft	St
Santa Rosa Creek	Restore channelized creek to more natural form and function	12.8	St
Rural Road Erosion Control			
Palmer	Erosion control, instream structures	1.5 +	Co, St
Santa Rosa (Hood Mt.)	Road and landslide erosion control	100 yds +	Co, St
Fish Passage			
Santa Rosa (Hood Mt.)	Rock weirs at stream crossing	10 miles upstream habitat	Co, St
PROJECTS THAT REQUIRE TAKE			
Instream Habitat Improvements			
Dry Creek	Instream habitat structures	14 miles	St, Co, Ch
Palmer	Instream habitat structures		St
Fish Passage			
Mumford	Engineering design plans, surveys for environmental permitting	50 miles upstream habitat	Co, St

[1]Co = Coho salmon, St = Steelhead, Ch = Chinook salmon

3.5.3 Water Conservation and Recycled Water

SCWA has completed a preliminary assessment of urban water reuse to evaluate the feasibility of recycled water projects. The assessment addressed the following elements of water conservation and recycled water use:

1. The potential reduction in peak demands on the water supply system that could be realized through the expanded use of tertiary-treated recycled water for irrigation.
2. The potential reduction in annual water supply demands from expanded use of tertiary-treated recycled water.
3. Order-of-magnitude costs (within 30 percent to 50 percent of actual cost) for construction and operation of recycled water distribution systems in urban areas.

In addition to the preliminary assessment for urban recycled water projects, SCWA is participating in a feasibility analysis of a storage and distribution system for the agricultural use of recycled water from the Geysers Recharge Project. This project would provide recycled water to agricultural users in the northern portion of Sonoma County. The water source is recycled water produced by local wastewater treatment facilities that is in excess of the amount that has been committed to other existing uses.

3.5.3.1 Recycled Water Feasibility Study

Background

SCWA provides a wholesale potable water supply for eight water contractors. These include the City of Cotati (Cotati), City of Petaluma (Petaluma), City of Rohnert Park (Rohnert Park), City of Santa Rosa (Santa Rosa), and City of Sonoma (Sonoma) and the Forestville Water District (Forestville), North Marin Water District (North Marin), and the Valley of the Moon Water District (VMWD).

Pursuant to the Eleventh Amended Agreement for Water Supply, SCWA may undertake cost-effective water conservation measures that will reduce demands on SCWA's water transmission system. The use of recycled water for irrigation in urban areas has the potential to reduce the peak summer demands on SCWA's water supply system. During the peak water demand periods, SCWA's water supply system is currently operating at capacity. If water demands continue to increase, SCWA's water supply system may be unable to meet peak demands for sustained periods.

Scope of Assessment

A preliminary assessment of urban reuse was performed, primarily using existing sources of information provided by SCWA's water contractors. These sources of information included:

- Existing water reuse studies
- Potable water use records

- Maps of existing and proposed recycled water distribution systems
- Agency construction-cost data

Several of SCWA's water contractors have conducted urban water reuse studies. Based on the review of these reports, the methodologies used to size and estimate construction costs for water reuse projects varied considerably between the water contractors. SCWA staff compiled and/or generated the necessary project components for the urban reuse projects and applied consistent cost estimates to each project. The cost estimates presented in the assessment represent order-of-magnitude estimates and are intended to allow comparisons of the costs and benefits of the various projects.

While these cost estimates can be used for preliminary planning purposes, a second-phase feasibility study of potential water reuse would provide a more accurate representation of the necessary components of urban water reuse systems and associated costs. This additional evaluation should include, but not be limited to, computer modeling of the pipeline systems, field surveys of potential pipeline routes, environmental concerns, and evaluation of the existing recycled water irrigation systems.

An assessment of the amount and location of recycled water releases is being developed, but is not available at this time.

Water Reuse Regulations

Opportunities for reducing potable water demands include the use of tertiary-treated recycled water for urban irrigation. Allowable uses of tertiary-treated recycled water are specified in the California Code of Regulations (CCR), Title 22. The definition of tertiary-treated recycled water is also presented in these regulations. Specifically, tertiary treatment is defined as a treatment process for wastewater that includes biological treatment, settling or clarification, coagulation, filtration, and disinfection.

Allowable uses of recycled water are specified in CCR Title 22, Section 60303. According to CCR Title 22, disinfected tertiary recycled water can be used for irrigation of the following:

- Food crops where the recycled water comes into contact with the edible portion of the crop, which includes all edible root crops
- Parks and playgrounds
- School yards
- Residential landscaping
- Unrestricted access golf courses
- Recreational impoundments
- Flushing toilets and urinals

- Decorative fountains
- Commercial laundries
- Any other irrigation use not specified in this section and not prohibited by other sections of the California Water Code

Irrigation area requirements for tertiary recycled water are also specified in CCR Title 22 and include the following:

1. No irrigation with disinfected tertiary recycled water shall take place within 50 feet of any domestic water supply well.

2. No impoundment of disinfected tertiary recycled water shall take place within 100 feet of any domestic water supply well.

3. Any use of recycled water shall comply with the following:

    - Any irrigation runoff shall be confined to the recycled water use area unless otherwise authorized by the regulatory agency.
    - Spray, mist, or runoff shall not enter a dwelling or a food handling facility.
    - Drinking water fountains and designated outdoor eating areas shall be protected against contact with recycled water spray, mist, or runoff.

4. All areas where recycled water is used and that are accessible to the public shall be posted with conspicuous signs, in a size at least 4 inches high by 8 inches wide, that include the following wording: "RECYCLED WATER - DO NOT DRINK."

5. Except as allowed under Section 7604 of Title 17, no physical connection shall be made or allowed to exist between any recycled water system and any separate system conveying potable water.

6. The recycled water system shall not include any hose bibs. Quick couplers that look different (for example, color coded) from those used on the potable water system may be used.

Water Supply Agreement

Based on the results of a reconnaissance-level study, it appears that the expanded use of recycled water use for irrigation within SCWA's service area could reduce both annual and peak potable water demands from the transmission system. It is estimated that: (1) 2,300 AF of water could be saved on an annual basis, and (2) the peak average month flow would decrease by about 5 mgd. A summary of the estimated capital and operation and maintenance (O&M) costs is presented in Table 3-9.

The total annual cost for providing recycled water to the sites can be estimated assuming: (1) construction of the improvements were financed through 20-year revenue bonds at an interest rate of 6.0 percent, and (2) average estimated O&M costs. Based on these assumptions, the construction and operation of the urban water reuse system described would cost approximately $1,000 per AF.

As indicated previously, the demand on SCWA's current water supply system can exceed its capacity during peak water use periods in the summer months. As the baseline demand for water increases, the number and duration of periods in which SCWA's water supply system is unable to meet peak demands may increase. The use of recycled water appears to be a feasible alternative for reducing demands on SCWA's water supply and transmission system.

The full development of a water reuse program could reduce the water contractor's demand on the SCWA system by about 3 percent annually and 5 percent during the peak average months. While cost for recycled water is greater than the cost of water produced by SCWA's existing water supply and transmission system, SCWA's existing system and water rights limitations may limit the amount of such water that is currently available. Therefore, the increased use of recycled water is necessary to allow SCWA to meet the future needs of its water contractors.

Table 3-9 Estimated Recycled Water Use and Capital and Operation and Maintenance (O&M) Costs

Water Contractor	Annual Recycled Water Use (AF)	Estimated Capital Cost	Estimated Annual O&M Cost
City of Cotati	30	$400,000	$100
Forestville Water District	50	600,000	75
North Marin Water District	650	8,800,000	100
City of Petaluma	640	5,800,000	80
City of Rohnert Park	90	800,000	80
City of Santa Rosa	440	3,600,000	80
City of Sonoma	135	1,100,000	80
Valley of the Moon Water District	275	3,100,000	90
Total	**2,310**	**$24,200,000**	**$90**

The recycled water use program would reduce potable water demands by about 2,300 AF and would cost about $24.2 million ($10,500 per AF) to construct. Based on the importance of this recycled water use program to maintain available potable water supplies for the water contractors and other water users, SCWA has indicated that this program could be supported through capital improvement funding in the amount of $10,000 per AF of potable water offset. This program would be phased in over a period of 5 years with full funding of $2 million per year available on year 5 through year 15 of implementation.

3.5.3.2 Agricultural Use of Recycled Water in North Sonoma County

SCWA, in cooperation with the U.S. Bureau of Reclamation (USBR), local agricultural water users, and local wastewater agencies, is assessing the feasibility of a storage and distribution system for the agricultural use of recycled water from the City of Santa Rosa's Geyers Pipeline that is more than the amount that has been committed to the Geysers Recharge Project and other existing uses. The proposed project will require the negotiation of agreements between the parties for project design, water delivery, and project financing.

This reuse of recycled water would improve the reliability of the water supply for agricultural purposes in North Sonoma County. The project would also assist SCWA with the development of solutions to address water supply, environmental, and regulatory concerns.

3.6 FISH FACILITY OPERATIONS

The USACE will continue to operate DCFH and CVFF. The existing facilities are described in Section 2.9, but the operations would be modified and additional facilities would be constructed under the proposed project. In 1999, a policy was implemented for DCFH and CVFF operations requiring that all broodstock be derived solely from adults captured within the Russian River (i.e., no out-of-basin stock transfers). This policy would be continued.

No coho salmon or Chinook salmon have been produced at the fish production facilities since 1998/1999. In October 1999, a meeting between USACE, CDFG, and NOAA Fisheries established an interim operations plan for the 1999/2000 operations at DCFH and CVFF. This plan called for the cessation of hatchery production of coho and Chinook salmon in the basin. Steelhead production goals remained unchanged from the original goals. Only returning adult hatchery steelhead are used for broodstock. In April 2000, the same agencies agreed to continue the interim operations plan until additional data were available regarding the genetic make-up of fish returning to the hatchery and those found in the wild (Interim Operations Memoranda October 15, 1999 and April 14, 2000).

In May 2001, CDFG submitted a permit application to NOAA Fisheries proposing a pilot program to analyze the effectiveness of a captive broodstock program for coho salmon in the Russian River. The pilot program was approved by NOAA Fisheries under Section 10 (a)(1)(A) of the ESA, authorizing "take" for the purposes of scientific research or enhancement activities. The program is authorized through June 2007 to allow time for adequate implementation and analysis of the enhancement response. A BO was issued on August 31, 2001 (NMFS 2001a). The program will rear juvenile coho salmon collected in the Russian River, use them as broodstock, and seed progeny into streams in the lower Russian River basin.

The proposed project for coho salmon is an integrated recovery program which includes this captive broodstock program. No Chinook salmon production is proposed at this time but is reserved for a future action. Under the proposed project the mitigation and enhancement goals for coho and Chinook salmon will be put on hold for an interim period. The mitigation obligations of USACE for coho salmon, steelhead, and Chinook salmon will be formally revised to provide objectives that are realistic and feasible under current environmental and regulatory conditions. A monitoring program will be implemented. Hatchery operations will incorporate adaptive management practices which could lead to changes in hatchery production guidelines (such as number of juveniles released, size of juveniles released, or use of wild fish for broodstock) based on findings of the monitoring program.

Draft Hatchery and Genetic Management Plans (HGMPs) for Russian River steelhead and coho salmon have been developed to support this consultation process (FishPro, Inc. and ENTRIX, Inc. 2002). These documents provide detailed information on these programs. The program descriptions and evaluations are summarized in this document. Modifications to the facility, including the installation of additional rearing tanks for coho salmon program, were made in the spring of 2003.

Supplementation programs for steelhead and Chinook salmon are evaluated in Section 3.6.5 as future actions that may be implemented if monitoring and evaluation indicate they are warranted.

The proposed action for steelhead is an isolated harvest mitigation program[2]. The steelhead program will maintain existing production and release goals. There is an apparent benefit that could be gained by incorporating wild steelhead into the hatchery broodstock source as a means to maintain genetic diversity and reduce domestication; however, it is necessary to first assess the abundance and viability of the remaining wild population before the risk of such an action can be quantified. An integrated recovery program for steelhead is assessed as an alternative action that would be implemented after additional genetic and population information becomes available. This alternative is presented in Section 3.6.5.

The proposed project will maintain mitigation elements for steelhead. Artificially produced steelhead will continue to provide harvest opportunities and a source for program broodstock. Monitoring efforts will be implemented to enable analysis of population trends for both naturally produced and hatchery-reared fish and to better quantify hatchery production performance.

The proposed project for coho salmon is an integrated recovery program[3]. The current program is a pilot captive broodstock program. The purpose of this program is to conserve genetic resources of the coho salmon population, which has extremely low

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[2]An isolated harvest program is: “a project in which artificially propagated fish produced primarily for harvest are not intended to spawn in the wild or be genetically integrated with a specific natural population.”

[3]An integrated recovery program is “an artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural populations(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as ‘supplementation’ (as defined in NOAA /Fisheries HGMP template Attachment 1).

population abundance and is at risk of extirpation. As with all supplementation programs, there is a strong demand for monitoring and evaluation of both the hatchery and natural populations as a means to measure the program effectiveness. Chinook salmon production will not be implemented at the present time. Based on the abundance data for Russian River Chinook salmon, the naturally spawning population appears to be large enough to not be at immediate genetic risk.

3.6.1 Program Goals and Objectives

Potential changes to existing and interim program goals were evaluated in the Benefit Risk Analysis (BRA) (FishPro, Inc. and ENTRIX, Inc. 2002). The evaluation considered many factors, including information collected in recent years regarding the status of listed species and habitat condition throughout the basin, as well as input provided by resource managers such as NOAA Fisheries and CDFG. Proposed changes to the current program goals are presented in Table 3-10. The proposed changes were based on analysis of potential risks and benefits of alternative fish production actions (Table 3-10).

The coho salmon program would be managed to aid in the recovery of the population. Implementation of the CDFG pilot captive broodstock program in 2001 is the first step. Steelhead production would be managed to maintain mitigation benefits and for its benefit to the fishery, but would incorporate changes in broodstock collection protocol to minimize domestication and potential genetic effects to the wild population.

Factors that influenced a change from existing goals include the following:

- Steelhead populations in the basin may be stable for both naturally reproducing and hatchery-reared fish. The existing hatchery program has successfully achieved production goals for smolt releases, but adult return rates are below the values estimated in the existing goals.

- Coho salmon populations appear to be at high risk of extinction in the Russian River basin. The recent implementation of the coho salmon supplementation program will provide critical information regarding the potential effectiveness of this conservation approach.

Some of the factors that influence a change from current goals to an integrated program include:

- Target release sizes that mimic the size of natural populations.
- Release locations limited to areas where there was historical production of natural populations.
- Release numbers that can be supported by current estimates of available carrying capacity for all subsequent life stages that will use the riverine habitat.
- Adult escapement numbers that reflect actual performance of adult return rates under recent habitat and ocean conditions.

Table 3-10 Proposed Yearly Program Goals for Russian River Hatchery Production

Species	Type of Program[1]	Juvenile Releases	Broodstock[2]
Coho salmon	Integrated recovery	50,000 fingerling 50,000 yearling	300 - 600
Chinook salmon	None (delay implementation until status is determined)	0	0
Steelhead (DCFH)	Isolated harvest	300,000 yearling	720
Steelhead (CVFF)	Isolated harvest	200,000 yearling	480

[1]Program types are selected from definitions in current template for Hatchery and Genetic Management Plan (HGMP) available at www.nwr.noaa.gov (see Glossary for definition of programs). It is assumed that an integrated program is more desirable than an isolated program as a means to minimize potential Effects that could arise from domestication and straying; however, the risk cannot be evaluated until current evaluations of genetics and stock origin are completed. Original mitigation and enhancement goals took into account harvest activities on all species; however, harvest is currently permissible only for hatchery steelhead, since the interim goals have ceased hatchery production of coho and Chinook salmon. A continued harvest is assumed as a long-term goal for the steelhead program based on apparent stability of the hatchery stock. A recovery goal is assumed for coho salmon, which has already begun implementation of a restoration program to avoid the risk of extinction; recovery is also assumed for Chinook salmon until a stable population is shown to exist.

[2]Broodstock collection goals reflect the estimated minimum number necessary to achieve juvenile release goals, or the minimum necessary to maintain genetic integrity, whichever is greater.

The broodstock collection numbers are based on estimates of the minimum number needed to achieve the juvenile release goal, based on expected survival for adult collection and rearing, egg incubation, and fingerling rearing, as well as other factors such as fecundity and spawning ratio. These production guidelines are based primarily on past performance of the DCFH and CVFF facilities (FishPro, Inc. and ENTRIX, Inc. 2001).

Another issue involving broodstock numbers relates to the genetic diversity of the population. The proposed release numbers provide sufficient adults to assure adequate broodstock for genetic diversity purposes and to allow for some latitude in variations to sex ratio and spawning success.

The greatest uncertainty in the production guidelines is the ability to estimate the adult returns back to the hatchery. Estimates for adult escapement have been based on a gross evaluation of fish releases and adult returns to DCFH and CVFF through 2000 (FishPro, Inc. and ENTRIX, Inc. 2001).

A hatchery monitoring and evaluation plan is essential to assess uncertainties regarding potential benefits and risks to natural populations of coho salmon, steelhead, and Chinook salmon.

Many fish production operations are similar at both DCFH and CVFF since they follow statewide policies and guidelines, or apply to the two facilities as an integrated program.

Detailed descriptions of the program goals, broodstock origin and identity, broodstock collection, incubation and rearing, releases, and adult returns are provided in HGMPs for proposed DCFH steelhead and coho salmon programs (FishPro, Inc. and ENTRIX, Inc. 2002). The following summarizes key information and describes proposed changes from recent operations.

3.6.2 Steelhead Mitigation Program

The current uncertainty regarding genetic divergence that may have occurred between the natural and hatchery stocks within the Russian River basin provides justification for an "isolated" program.

The proposed isolated harvest program for steelhead would continue the objectives of the existing steelhead mitigation program. The program would collect returning hatchery-reared steelhead and use them as broodstock to produce fingerling. The fingerling would be subsequently released as smolts directly in Dry Creek, or transported to CVFF for acclimation and volitional release in the upper Russian River basin. The objectives of the isolated harvest mitigation program are to 1) compensate for the loss of steelhead production behind WSD and CVD, 2) provide a fishery for hatchery-reared steelhead in the Russian River basin, and 3) minimize ecological interactions with the wild Russian River steelhead population by purposefully striving to isolate the spatial and temporal overlap of habitat utilization by the wild and hatchery-reared components.

The timeframe necessary to measure and evaluate the objectives is estimated to be a minimum of three generations, so that a statistically significant number of samples can be obtained for analysis. For the isolated harvest alternative, this timeframe is estimated to be 15 years, assuming 5 years to be the average length of a steelhead generation.

3.6.2.1 Broodstock Collection

The isolated harvest program would derive all broodstock from the supply of adult steelhead returning to the hatchery. Broodstock for the DCFH program are collected from fish returning to the DCFH ladder and trap, while those for the CVFF program are collected from fish returning to the CVFF ladder and trap. All wild adult steelhead returning to DCFH are relocated to tributary streams of Dry Creek and all wild adult steelhead returning to CVFF are relocated to the west branch of the Russian River above Mumford Dam or on the East Fork near Forsythe Creek. In a change to past protocols, all surplus hatchery adult steelhead returning to the fish facilities would not be returned to the watershed, but would be destroyed to minimize potential interactions with naturally spawning fish. Table 3-11 summarizes the proposed annual broodstock collection level for steelhead.

Table 3-11 Proposed Annual Broodstock Collection Level (Maximum Number of Adult Fish) for Steelhead

	DCFH	CVFF
Females	180	120
Males (including jacks)	540	360

Under baseline conditions, some of the eggs from a coho salmon stock in the Noyo River were kept at DCFH and reared for planting into the Russian River for enhancement purposes, but both this practice and the entire Noyo River incubation program were discontinued after 1999.

Releases

The proposed annual fish-release levels for steelhead are summarized in Table 3-12.

Table 3-12 Proposed Annual Fish Release Levels (Maximum Number) by Life Stage and Location for Steelhead

Life Stage	Maximum Number	Size (fpp)	Release Date	Release Location
Eyed Eggs	0	NA	NA	NA
Unfed Fry	0	NA	NA	NA
Fry	0	NA	NA	NA
Fingerling	0	NA	NA	NA
Yearling – DCFH	300,000	4	Jan – Apr	Dry Creek (Yoakim Bridge)
Yearling - CVFF	200,000	5	Jan - Apr	East Fork Russian River (CVFF)

3.6.2.2 Release Protocols

The management plan for steelhead releases has been recently modified. Each year, typically beginning in December and continuing through April, grading operations were conducted on steelhead to identify fish larger than 4 fish per pound, and they were then released. Previously, any remaining fish that did not meet size criteria were released by the end of April regardless on size. This practice was discontinued beginning in July 1999 and these undersized fish are no longer released.

Also, practices relating to surplus egg-takes have been modified. In the past, if egg-take goals were exceeded, some of the eggs were stocked within the drainage as fry and fingerling to spread the egg-take proportionate to the entire run. As of July 1999, surplus eggs are destroyed.

Yearling smolt steelhead from DCFH are released in Dry Creek, three miles downstream from the hatchery at Yoakim Bridge. Yearlings from CVFF are released at the discharge point of the CVFF facility. DCFH releases are forced, while CVFF releases are volitional during a one-month acclimation period, and then forced at the end of the period. Because fish released from the DCFH are spawned, incubated, and reared in the water they are released in, they are acclimated for their entire juvenile lifestage. Fish released at CVFF are transported to the facility from DCFH approximately 30 days before their release. Hatchery-reared steelhead are released at a larger size than their naturally spawned counterparts would be at the same age.

3.6.2.3 Harvest Management

Current fishing regulations allow the take of hatchery-reared steelhead. (Steelhead released from DCFH and CVFF would be marked with clipped adipose fins.) Harvest of naturally spawned steelhead is prohibited. There are no current estimates of harvest levels of steelhead within the Russian River, but there is indication that funding soon may be available for a project to estimate harvest levels (Royce Gunter, CDFG, pers. comm. January 8, 2002). Recent investigations are beginning to survey adult returns to the Russian River for both hatchery-reared and naturally spawned population components.

3.6.2.4 Monitoring and Evaluation

Criteria for evaluating success of the isolated harvest program involve measurement of the following critical areas:

1. The numbers of adult hatchery-reared steelhead returning to the Russian River basin (including those harvested by commercial and recreational fishers) meeting or exceeding the escapement goals.

2. Population assessments indicating an increasing trend in the number of adult steelhead returning to spawn in the Russian River, with measured adult-to-adult replacement greater than or equal to one. This population assessment includes adults of both the hatchery-reared and naturally spawned components.

3. Population assessments conducted in release streams indicating no change or an increase in abundance of the wild population.

4. Genetic assessments of both the wild and hatchery-reared components conducted over time showing no loss or an increase of genetic variation in either component; divergence of the two components are acceptable, depending on the desired level of stock isolation.

Performance indicators, as well as plans proposed for monitoring and evaluation of those performance indicators, are presented in the draft DCFH steelhead HGMP (FishPro, Inc. and ENTRIX, Inc. 2002b).

3.6.3 Coho Salmon Integrated Recovery Program

A captive broodstock program for coho salmon would have similar objectives to the existing CDFG pilot captive broodstock program. The program would continue to collect naturally produced juvenile coho salmon, rear the fish to maturity, and subsequently use them as broodstock to produce fingerlings. The fingerlings would subsequently be released into appropriate streams in the Russian River basin. The objectives of the captive broodstock program are to 1) prevent extirpation of Russian River coho salmon, 2) preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species, and 3) build a naturally sustaining coho salmon population. It serves a secondary purpose of research, providing information regarding how to effectively use artificial propagation to address other goals.

The timeframe necessary to measure and evaluate the objectives is estimated to be a minimum of five salmon generations, in order that a statistically significant number of samples can be obtained for analysis. For the captive broodstock program, an additional four years of start-up time is necessary to allow for broodstock growth to sexual maturity following the initial capture of adults.

3.6.3.1 Broodstock Collection

The proposed program calls for the collection of 300 to 600 juvenile coho salmon annually for potential use as broodstock followed by rearing in captivity until the fish reach maturity. Electrofishing for juvenile coho salmon from selected streams will be conducted between March and November. Procedures for electrofishing will be employed as specified in Permit 1067 (NMFS 2001). Broodstock would be collected from a random selection of juvenile coho salmon encountered during each electrofishing capture event. To preserve the naturally-reproducing component of the stock, no more than 50 percent of the juvenile fish encountered will be collected. Of 344 juveniles collected in September 2001, there were 308 on hand as of May 2002. Gender proportions have not yet been determined. Assuming a spawn of 100 females, there will be an approximate egg take of 230,000.

Determination of the specific streams that will be surveyed each year will be developed in consultation with NOAA Fisheries and the Technical Oversight Committee (TOC) as long as it is active. The preferred source to obtain broodstock is from within the Russian River basin. Streams that have been identified for possible sources include Green Valley, Purrington, Freezeout, Willow, Ward, Sheephouse, and Felta creeks. If insufficient numbers are obtained after initial collection efforts, then additional collection may be conducted if suitable watersheds can be identified. The risks of inbreeding versus outbreeding depression would be carefully weighed before out-of-basin transfer would occur. Collection efforts will be adjusted as genetic information is developed on the relationships between Russian River stocks and populations in other candidate watersheds.

The TOC will evaluate the best strategies to increase genetic diversity during the initial captive brood maturation period, and will make a recommendation before the first spawning anticipated in late 2003 or early 2004. State-of-the-art genetic analyses will be conducted for all fish used in the program, and the results of the analyses will be used to dictate the combinations of mature coho salmon to use in the spawning process.

Most coho salmon mature in their third year, but some fish, typically males, will mature a year early. It is possible that some captive brood will mature early, and/or it may be possible to induce precociousness through hormone treatments. The TOC will evaluate the potential benefits of using precocious males to transmit genetic material between year classes, thereby increasing genetic diversity and/or supplementing weak year classes. The TOC will evaluate the feasibility of cryopreservation of milt and the cost of associated equipment and implementation, and provide the findings in the first annual report for the program.

3.6.3.2 Releases

Table 3-13 summarizes the proposed annual fish release levels and locations for coho salmon.

Table 3-13 Proposed Annual Fish Release Levels (Maximum Number) by Life Stage and Location for Coho salmon

Life Stage	Maximum Number	Size (fpp)	Release Date	Release Location
Eyed Eggs	0	NA	NA	NA
Unfed Fry	0	NA	NA	NA
Fry	0	NA	NA	NA
Fingerling	50,000 (10,000 each stream)	NA	Mar - Apr	5 streams: Willow, Sheephouse, Freezeout, Mill, Ward
Yearling	50,000 (10,000 each stream)	5	Jan - Apr	5 streams: Willow, Sheephouse, Freezeout, Mill, Ward

The TOC will make recommendations to NOAA Fisheries regarding disposition of any excess eggs, fingerlings, or smolts beyond the current 200,000 smolt goal.

Rearing pond densities for fish to be released will be managed so they do not exceed 2.25 lbs. fish/ cubic feet (ft^3). Lower densities will be maintained whenever possible. Rearing pond densities for the captive broodstock will be managed so they do not exceed a maximum density of 1.0 lbs. fish/ft^3.

3.6.3.3 Release Protocols

All coho salmon fingerling and smolts released as part of the coho salmon recovery program will be marked with a Passive Integrated Transponder (PIT) tag. All juvenile fish collected as part of the broodstock collection efforts will be assayed with PIT tag scanning equipment. Any captured coho salmon that are found with a tag will be released back to their capture location. The TOC will evaluate the potential benefits of using Soft Visible Implant Alphanumeric (VI-alpha) tags in future crops, as these tags allow immediate visual identification of marked fish.

Fish will be reared and released at a size that mimics the size of natural fish of the same age to minimize the risk of predation and competition with natural fish upon release. In the BO for Permit 1067 (NMFS 2001), the preferred release strategy is the release of smolts, with a second preference for the release of fingerlings. A factor in this preference may be the anticipated mortality of 90 percent of fingerlings before they reach the yearling stage, as is commonly assumed for wild populations (NMFS 2001). If there are sufficient numbers to allow for release of both smolts and fingerlings, then an experimental release program would be implemented to allow comparison between the two release strategies as necessary.

Coho salmon to be released as smolts will be held in net pen acclimation devices at the release site for not less than 30 days to facilitate imprinting. Net pens will be monitored daily during this period. Net pen materials, dimensions, and rearing density criteria will be established by the TOC before the first release of coho salmon smolts, scheduled to occur in 2005. To minimize competition between hatchery-reared and naturally spawned fish, fingerling and smolt releases will occur where there are no known populations of wild fish.

3.6.3.4 Monitoring and Evaluation

Criteria for evaluating success of the captive brood program involve measurement of the following critical areas:

1. Population assessments indicating an increasing trend in the number of adult coho salmon returning to the Russian River, with measured adult-to-adult replacement greater than or equal to one.

2. Population assessments conducted in release streams indicating no change or an increase in abundance of the naturally spawning component.

3. Genetic assessments of both the naturally spawning and hatchery-reared components conducted over time showing no loss or an increase of genetic variation in each component.

Performance indicators, as well as plans proposed for monitoring and evaluation of those performance indicators, are presented in the DCFH steelhead HGMP (FishPro, Inc. and ENTRIX, Inc. 2002).

A long-term comprehensive monitoring program for stream condition and adult and juvenile abundance is being developed by the capture, release, and monitoring subcommittee of the Russian River Coho Salmon Captive Broodstock Program Workgroup.

3.6.4 Facility Changes

Existing hatchery facilities and proposed modifications to DCFH are described in detail in the draft HGMPs for steelhead and coho salmon. This section summarizes proposed modifications.

3.6.4.1 Potential Expansion

The proposed coho salmon supplementation program would require a central rearing and incubation facility and at least one acclimation pond. An assessment of potential future hatchery expansion needs is currently being conducted.

The acclimation pond(s) would be located in tributaries of the Russian River where there is good quality but underused habitat. Acclimation ponds would be considered for Willow, Sheephouse, Freezeout, Mill, and Ward creeks.

3.6.4.2 Water Supply Modification

The total hatchery water demand for the baseline mitigation program for full-capacity fish production operations is 25 cfs. When broodstock collection and holding operations are occurring, the demand increases to approximately 35 cfs to provide attraction flows for adult fish migrating upstream and to provide flows to maintain the fish in holding ponds once they enter the hatchery. Currently, water for the hatchery is taken from the outlet works of the stilling basin of WSD. An emergency water supply is used to supply a sufficient quantity of water to the hatchery when the outlet works and power plant are not operating.

A new water supply would be constructed for the DCFH that would tap into the existing wet well and provide a single pipeline capable of delivering 50 cfs of gravity flow reservoir water to the DCFH facilities. The new water supply will eliminate the need for the emergency water supply system and the existing emergency supply pipeline would be removed.

3.6.4.3 DCFH Coho Salmon Captive Broodstock Program Water Quality Considerations

The primary chemicals used in captive breeding are vaccines, antibiotics, chlorine, along with chlorine neutralizer, and salt to address disease concerns. Sex hormones are used to increase development since maturation can lag in the captive animals relative to their wild counterparts. Anesthesia is typically used whenever captive animals are handled for any of these activities.

A permutation of disease control found in captive broodstock programs is the constant disinfection of the waste stream once a parasite or contagion is confirmed and there are no other options to treat the flow through water than ongoing disinfection of the effluent stream. Unlike conventional hatcheries, which release fish as smolts, captive broodstock programs rear salmon for the full term of life history. This extended holding to reach maturation creates disease factors which increase significantly in complexity over time and as multiple cohorts, representing numerous families, are reared in the same program. Infected animals are usually maintained and not destroyed due to the rare genes they represent. This creates a situation where large animals may be constantly shedding pathogens.

Effluent streams flowing from known infected stocks can have chlorine gas injected into the outfall flowing from the facility. The chlorine, after adequate contact time, is then neutralized by sodium thiosulfate, This real time disinfection system can be deployed in an automated design with both the chlorine and sodium thiosulfate injected in gaseous form in a constant rate into the piping. Care has to be provided to confirm adequate chlorine contact time to ensure killing the contagion. Further, advanced facility design can include human-machine interface tools along with graphic user interface software for real-time monitoring and shutdown capability should one or more components fail. These technologies are routinely used at the Cle Elum Conservation Hatchery in Washington and to a more advanced degree at BML.

One great advantage of these technologies in California is the added credibility an operation maintains with regulatory agencies, such as the RWQCB, due to the continuous operational record such systems provide. The reliability represented by an automated interlocked shutdown of pumps to stop the waste stream if chlorine injection fails can have several layers of redundant backup integrated mechanically and through the automated control software.

The DCFH Coho Salmon Captive Broodstock program qualifies for NOAA permit exemption for the use of chemotherapeutics through qualification under the Threatened and Endangered Species permit process. However, this applies only to the use of vaccines and treatments on endangered salmon and does not exempt the operator from state and federal environmental compliance. Vaccines; antibiotics used to treat salmonid diseases; disinfectants to sterilize tanks, pipe, and decks; and hormones to boost maturation must be removed from the effluent stream. Carbon filtration is the conventional method to treat effluent from fish production facilities including captive broodstock programs. When chlorine is used as a disinfectant, sodium thiosulfate is used to reduce chlorine and neutralize it to meet NPDES requirements.

Captive broodstock salmon require routine inventories for data collection, vaccination, treatment, and assessment for maturation. Coho salmon are considered a three-year-old species. During the course of a three year captive rearing regime coho salmon may be handled a few times in the first year then with increasing frequency up to spawning. Captive artifacts resulting in asynchronous growth and maturation require routine inventories especially as the fish are assessed in their terminal year as spawning candidates. Weekly handling is not uncommon when individual spawners representing rare family groups need to be monitored for maturation to fit into a spawning matrix.

In the terminal year large numbers of broodstock may be handled once a month or more frequently if culling for rare genes requires artificially boosting maturation through the use of sex hormone (typically gonadaltropin releasing hormone [GnRH]) or analogs. Hormones or analogs can be injected or inserted as implants and the amount entering the rearing environment may be nondetectable. However, precaution in the form of adequate filtration, must be employed prior to the use of hormones.

The most common chemicals, both in numbers and volumes, used in captive breeding are those dealing with disease prevention and treatment. The coho salmon disease of greatest concern is bacterial kidney disease (BKD) caused by *Renibacterium salmoninarium.* Currently the juvenile fish at DCFH are being vaccinated with renogen. The recommended dosage for fish larger than 10 grams is 0.1 milliliter (ml).

If the captive broodstock fish become symptomatic for BKD as they mature they will likely be treated with erythromycin. Azithromycin is also used for treating BKD but the efficacy is in question.

Products commonly used in captive broodstock programs include:

- Anesthesia – Finquel™ or MS-222™. Each are a form of tricaine methanosulfanate. Also, in common usage, are various forms of quinaldine (2-methylquinoline), and to a lesser degree, 2-phenoxyethanol. Tricaine concentration = 1:2000 – 1:3000. Usually fish are anesthetized in a discrete bath enclosure with water that does not enter the effluent. However, this water requires filtration to minimize the chance of antibiotics entering the environment.

- Salt – The common treatment for fungal diseases, the most common being *Saprolegnia*. *Saprolegnia* could become a problem when rearing fish to adults in freshwater. Salt concentrations for treating fungal diseases range from 3 ppt – 8 ppt or higher.

- Vaccination for *vibvio* – If the animals are reared in salt water, then *vibrio* becomes a concern and vaccination for *vibrio* is required.

- Antibiotic injection or penicillin bath – Cold Water Disease caused by the agent *Flavobacterium psychrophilium* may be of real concern at DCFH. This bacterial disease has been documented at DCFH and occurs frequently in steelhead and rainbow trout. Treatment is typically by antibiotic injection or penicillin bath.

- Teramycin bath – Currently the coho salmon at DCFH undergo protocols for newly hatched fish, which includes a.

- Chlorine Disinfect – Tanks, holding bins, boots, and almost anything coming into contact with water that has contacted fish will be routinely disinfected with chlorine as part of a disease control protocol. Large-volume water containers such as raceways or tanks disinfected with chlorine will usually sit as a static bath for a few hours. This volume of diluted chlorine will then be neutralized by the addition of sodium thiosulfate.

3.6.5 FUTURE SUPPLEMENTATION PROGRAMS

As part of the regulatory framework provided by ESA, NOAA Fisheries has established nine domains spanning the geographic range of listed West Coast salmon and steelhead, with the intent of developing comprehensive recovery plans for all listed ESUs within each domain. The Russian River is located within the North-central California Coast domain. Some of the initial efforts that will be completed through the recovery planning process are 1) an evaluation of the current status of the listed population or species, 2) an assessment of the factors affecting the species, and 3) an identification of recovery (delisting) goals. As new information becomes available from the recovery planning regarding the status of Russian River populations, the DCFH and CVFF may be able to contribute to recovery efforts in ways that differ from the proposed programs presented in the previous section.

Under the proposed project, the recommended hatchery programs are an isolated harvest program for steelhead, a supplementation program for coho salmon, and no production for Chinook salmon. If new information indicates it is warranted, alternative hatchery production programs for each of the three listed species may be implemented. The programs would be formulated to have the least possible effect on the wild populations for each of the three listed species given the current understanding of each species' population and genetic characteristics.

The use of hatcheries to supplement wild stocks is a controversial topic, in part due to confusion over the definition of the term. NOAA Fisheries (Flagg et al. 2000) suggests the most practical definition may be:

> *Supplementation is the stocking of fish into natural habitat to increase abundance of naturally reproducing fish populations.*

NOAA Fisheries has recommended that supplementation of a population may be appropriate if (Flagg et al. 2000):

- The wild population is declining.
- Sufficient spawning habitat is available and underused.
- Other actions which could address the cause(s) of population declines cannot be implemented in a timely manner.
- Hatchery technology and facilities are available to increase stock productivity above replacement.

The DCFH and CVFF provide a rare opportunity for rapid implementation of a supplementation program, should the conditions described above be found to exist for steelhead or Chinook salmon in the Russian River. A proposed program for steelhead production, referred to as an integrated harvest, is presented below. This program for steelhead differs from the isolated harvest program described above. The difference is primarily the use of wild steelhead broodstock rather than using returning hatchery-reared fish, thus reducing the risk of genetic effects to the wild population. The implementation of this program assumes that the wild steelhead population is stable or increasing, which again is dependent on the results of population studies that are likely to be completed through recovery planning efforts. In addition, a Chinook salmon supplementation program is described and analyzed, in case future data show the Russian River Chinook salmon population to be below the viable population threshold. (Coho salmon are not considered in this analysis since the proposed coho salmon program presented in the BA consists of supplementation.)

3.6.5.1 Steelhead Integrated Harvest Program

Program Objectives

The proposed future integrated harvest program for steelhead would meet the objectives of the existing steelhead enhancement program, except that wild steelhead salmon would be used as broodstock to eliminate genetic differences between the hatchery-reared and naturally spawning components. Additionally, the integrated harvest program would include a supplementation component to compensate for the numbers of broodstock collected from the wild, as well as to increase the population of naturally spawning steelhead. The objectives of the integrated harvest enhancement program are to: 1) provide a fishery for hatchery-reared steelhead in the Russian River basin, 2) contribute to the naturally spawning steelhead population at a level greater than the level of broodstock collection from the wild, and 3) preserve genetic, ecological, and behavioral attributes of wild Russian River steelhead while minimizing potential effects to other stocks and species.

Criteria for evaluating success of the integrated harvest program involve measurement of the following critical areas:

- The numbers of adult hatchery-reared steelhead returning to the Russian River basin (including those harvested by commercial and recreational fishers) meeting or exceeding the escapement goals.

- Population assessments indicating an increasing trend in the number of adult steelhead returning to the Russian River, with measured adult-to-adult replacement greater than or equal to one. This population assessment would include adults of both the hatchery-reared and naturally spawned components, since presumably there would be no genetic difference between the two components.

- Population assessments conducted in release streams indicating no change or an increase in abundance of the naturally spawning component.

- Genetic assessments of both the naturally spawning and hatchery-reared components conducted over time showing no loss or an increase of genetic variation in each component.

Estimated Timeframe to Achieve Objectives

The timeframe necessary to measure and evaluate the objectives of a steelhead integrated harvest program is estimated to be 17 years. This timeframe includes a period of three generations, so that a statistically significant number of samples could be obtained for analysis. Assuming 5 years to be the average length of a steelhead generation, the period of three generations is 15 years. An additional two years of start-up time is necessary to allow for the first cycle of adult collection and fingerling production.

Program Description

The steelhead supplementation program recommended for the Russian River basin consists of the following components:

- Wild adult steelhead will be collected at a location downstream of the supplementation stream release location. A broodstock collection goal of 269 wild adult steelhead has been established based on consideration of several factors including minimum effective population size, estimated productivity of the wild population, and estimated smolt-to-adult return rate for the hatchery population (Table 3-14). It is assumed that an adult trapping, sorting, and collection facility would be developed at a suitable location before implementation of the supplementation program. (Wild broodstock collection at the existing DCFH and CVFF traps is not feasible since there is no spawning habitat upstream of the traps, and thus no measures for attracting wild fish into the traps.)

- The wild steelhead broodstock will be transported to existing holding facilities at DCFH and will be spawned there when ripe. The same site will used to provide incubation of 638,500 eggs and rearing facilities for 500,000 pre-smolt fingerling. Though these fish are the progeny of wild broodstock, all fish will be marked with a coded wire tag or similar unique marker to identify them as hatchery-reared fish.

- Smolts will be released from a minimum of three locations. 200,000 smolts will be released into the East Fork Russian River through volitional release from CVFF following a one-month acclimation period (as is done with the existing isolated harvest program). Another 230,000 smolts will be released directly into Dry Creek from DCFH. The final 70,000 smolts will be used to supplement the naturally spawning population by releasing the fish into one or more selected streams having total available spawning capacity for about 700 steelhead adults. As hatchery-reared fish, all adults returning from these smolt releases will be subject to harvest. However, assuming a harvest rate of 15 percent, there will be approximately 595 fish returning to the supplementation streams, thereby providing sufficient numbers of naturally spawning broodstock to produce wild steelhead progeny (i.e., the F_2 generation) that can in turn serve as wild broodstock for the integrated harvest program without concern for genetic effects.

- An annual monitoring and evaluation plan will be implemented to evaluate, at a minimum: 1) the population abundance of both hatchery-reared and naturally spawned adults returning to the Russian River, as measured at the adult collection facility; 2) the population abundance of the specific release streams; 3) and a genetic assessment of both the naturally spawning and hatchery-reared components conducted over time to assure there is no loss of genetic variation in each component. Additional monitoring parameters are recommended in the HGMP.

Table 3-14 Steelhead Integrated Harvest Program Assumed Conditions and Facility Production Guidelines

	DCFH	CVFF	Supplementation Streams
Minimum number broodstock collected	161	108	NA
Spawning Male:Female ratio	1:1	1:1	NA
Pre-spawning survival	95%	95%	NA
Females spawned	77	51	NA
Fecundity	5,000	5,000	NA
Total egg take	383,100	255,400	NA
Survival - egg take to fry ponding	87%	87%	NA
Total fry ponded	333,300	222,200	NA
Survival - ponding to smolt release	90%	90%	NA
Total F1 smolt released or transferred	300,000	200,000	NA
On-site releases	230,000	200,000	70,000
Supplementation stream transfers	70,000	0	0
Size at smolt release	6.8 inches	6.8 inches	6.8 inches
Period of smolt release	Jan-Apr	Jan-Apr	Jan-Apr
Survival - smolt release to adult return	1.0%	1.0%	1.0%
F1 adults returning (before harvest)	2,300	2,000	700
Estimated harvest (15%)	345	300	105
Broodstock reserve (use F2 if available)	161	108	0
Fish passed for natural spawning	0	0	595
Est. productivity of nat.-spawn. pop.	NA	NA	0.5
Estimated wild (F2) adult return	NA	NA	298
Target F2 broodstock collection	NA	NA	**269 - OK**

(OK; will pass broodstock reserve, plus productivity should improve.)

3.6.5.2 Chinook Salmon Supplementation Program

Program Objectives

The Chinook salmon supplementation program would collect wild returning adult Chinook salmon and uses them as broodstock to produce fingerlings in the hatchery. The fingerlings would be subsequently seeded into appropriate streams in the Russian River basin. The objectives of the supplementation program are to: 1) prevent extirpation of Russian River Chinook salmon, 2) preserve genetic, ecological, and behavioral attributes of Russian River Chinook salmon while minimizing potential effects to other stocks and species, and 3) build a naturally sustaining Chinook salmon population.

Criteria for evaluating success of the supplementation program are:

- Population assessments indicating an increasing trend in the number of adult Chinook salmon returning to the Russian River, with measured adult-to-adult replacement greater than or equal to one. This population assessment would include adults of both the hatchery-reared and naturally spawned components, since presumably there would be no genetic difference between the two components.

- Population assessments conducted in release streams indicating no change or an increase in abundance of the naturally spawning component.

- Genetic assessments of both the naturally spawning and hatchery-reared components conducted over time showing no loss or an increase of genetic variation in each component.

Estimated Timeframe to Achieve Objectives

The timeframe necessary to measure and evaluate the objectives of a Chinook salmon supplementation program is estimated to be 17 years. This timeframe includes a period of five generations, so that a statistically significant number of samples could be obtained for analysis. Assuming 3 years to be the average length of a Chinook salmon generation, the period of five generations is 15 years. An additional two years of start-up time is necessary to allow for the first cycle of adult collection and fingerling production. A secondary factor in selecting program duration is an assumption that habitat restoration efforts within the Russian River may require 10 to 20 years.

Program Description

The Chinook salmon supplementation program recommended for the Russian River basin consists of the following components:

- Wild adult Chinook salmon will be collected at a location downstream of the supplementation stream release location. A broodstock collection goal of 242 wild adult Chinook salmon has been established based on consideration of several factors including minimum effective population size, estimated productivity of the wild population, and estimated smolt-to-adult return rate for the hatchery population (Table 3-15). It is assumed that an adult trapping, sorting, and collection facility would be developed at a suitable location before implementation of the supplementation program, and conceivably this collection facility could be developed at Mirabel dam. (Wild broodstock collection at the existing DCFH and CVFF traps is not feasible since there is no spawning habitat upstream of the traps, and thus no measures for attracting wild fish into the traps.)

- The wild Chinook salmon broodstock will be transported to existing holding facilities at DCFH and will be spawned there when ripe. The same site will be used to provide incubation of 460,000 eggs and rearing facilities for 360,000 fingerling smolts. All fish will be marked with a coded wire tag or similar unique identifier prior to release.

- The 360,000 fingerling smolts will be released into one or more selected streams having total available spawning capacity for at least 478 Chinook salmon adults.

- An annual monitoring and evaluation plan will be implemented to evaluate at a minimum 1) the population abundance of both hatchery-reared and naturally spawned adults returning to the Russian River, as measured at the adult collection facility; 2) the population abundance of the specific release streams; and 3) a genetic assessment of both the naturally spawning and hatchery-reared components conducted over time to assure there is no loss of genetic variation in each component.

Table 3-15 Chinook Salmon Supplementation Program Assumed Conditions and Facility Production Guidelines

Target number wild broodstock	242
Spawning Male:Female ratio	1:1
Pre-spawning survival	95%
Females spawned	115
Fecundity	4,000
Total egg take	459,800
Survival - egg take to fry ponding	87%
Total fry ponded	400,000
Survival - ponding to smolt release	90%
Total F1 smolt released	360,000
Size at smolt release	3.6 inches
Period of smolt release	Mar-May
Survival - smolt release to adult return	0.20%
F1 adults returning	720
Broodstock reserve (prefer F2)	242
Fish passed for natural spawning	478
Est. productivity of nat.-spawn. pop.	0.5
Estimated wild (F2) adult return	239
Target F2 broodstock collection	242

3.7 Required Changes to Institutional Agreements and Constraints

To implement the proposed changes and modifications to the facilities and operations described in the preceding sections, several of the existing Institutional Agreements and Constraints will require revision. This section identifies and briefly describes the required changes.

3.7.1 SWRCB Decision 1610

D1610 and SCWA's water rights permits specify the existing flow regime in Dry Creek and the Russian River. D1610 and SCWA's permits will need to be amended so that the proposed flows described in Section 3.2 may be implemented. If Decision 1610 is not amended, the proposed Estuary management action could not be implemented.

3.7.2 Warm Springs Dam Hydroelectric Facility

The FERC license granted to SCWA to operate the WSD hydroelectric facility incorporated the D1610 minimum flow requirements. Because proposed Dry Creek flows will be less that the D1610 minimums that were incorporated into the FERC license, amendment of the FERC license will be required.

Under SCWA's power sale contract with PG&E, SCWA receives "capacity" payments from PG&E in addition to payments for power actually delivered. The capacity payments are based upon a "firm capacity" of 1.246 megawatts during the summer months. Because the hydroelectric turbines at WSD cannot be operated at flows less that 70 cfs, SCWA would be not be able to provide the "firm capacity" contemplated by the power sale agreement with PG&E. This will result in reduced revenue to SCWA and the possible de-rating of the capacity of the WSD hydroelectric facility.

3.7.3 USACE Channel Maintenance Requirements

USACE would revise their channel maintenance requirements to reflect the implementation of focused channel maintenance and vegetation clearing activities that provide greater protection for listed fish species. The existing O&M manuals for the CVDP and WSDP were authorized by Congress.

3.7.4 Fish Production Facilities

The mitigation and enhancement goals for coho salmon and Chinook salmon would be put on hold for an interim period. The mitigation and enhancement obligations for USACE for coho salmon, steelhead, and Chinook salmon will be formally revised under current environmental and regulatory conditions.

INTRODUCTION

Evaluation criteria were developed to assess or scale the effects of MCRRFCD, SCWA, and USACE activities on listed fish species and their habitat in a semi-quantitative way. These criteria provide the basis for an objective evaluation of the various activities and facilities that are included in the proposed project.

Evaluation criteria provide the basis for assigning an effect score for such effects as modifications to water temperature, habitat, sedimentation, scour, and so on. The assessment is based on a consistent set of evaluation categories and criteria for life-history stages of coho salmon, steelhead, and Chinook salmon and their habitats in the Russian River, Dry Creek, and tributaries. The criteria provide a consistent means of evaluation of a specific effect by species and life-history stage, and location. For instance, coho salmon may not use some areas in the watershed for juvenile rearing so there would be no reason to evaluate these areas for an effect on coho salmon rearing as long as the facility or operation component had only localized affects. Evaluations can also be based on restoration or recovery benefits.

To simplify comparisons between facilities, locations, and effects, a consistent and simple scoring is applied to the evaluations. The scoring system then facilitates a consistent comparison strategy and analysis. Other benefits of this scoring process include the ability to make the process of scoring automated for hydrological time series and model outputs. This makes the scoring even more objective. It also facilitates the integration process because the scores can be integrated by species, location, and project component.

The evaluation criteria and scoring were developed after review of the available information and consultation with appropriate technical resources, including staff from USACE, SCWA, CDFG, NOAA Fisheries, and others. Preliminary criteria were presented in a meeting to the USACE, SCWA, CDFG, NOAA Fisheries, and the RWQCB by ENTRIX scientists. The criteria, the basis for the criteria, and how they would be applied were explained at this meeting. Comments on the proposed criteria were addressed.

Project features and operations have the potential to directly or indirectly affect listed fish species and their habitats. In the course of consultation with USACE, SCWA, NOAA Fisheries, and other resource agencies, specific actions associated with Project features and actions under baseline conditions were identified. The scoring criteria were used in the *Interim Reports* (ENTRIX, Inc. 2000a-b, 2001a-d, 2002a, FishPro and ENTRIX, Inc. 2000) to evaluate USACE and SCWA activities and operations under baseline conditions. Alternative actions were evaluated, and the constraints and agreements affecting each alternative were incorporated into this evaluation (ENTRIX, Inc. 2002d, 2003b). Net benefits for recovery, and alternatives with greater benefits, were identified and incorporated into the proposed project. The effects of proposed project features or activities on the target fish species or their habitats will be evaluated in the BA. Each of the categories for potential effects to the fish and their habitats will be evaluated using objective criteria, specific to the aspect of the fishes' life history or habitat affected. Once the effects of individual project operations are assessed, they will be integrated across all project operations to assess the total potential effects on each species and each life-history stage.

4.1 CRITERIA FOR WATER QUALITY

Habitat suitability may be affected by a number of factors. These include water temperature, DO, turbidity, and flow, among others. This section describes the evaluation criteria developed for water-quality parameters, which include temperature, DO, and turbidity.

4.1.1 TEMPERATURE

To quantify the effect of water temperature on salmonid persistence, evaluation criteria that assign scores to various temperature ranges were developed. Literature values for salmonid temperature tolerances vary with species and by geographic region. Most of the literature values used to develop the criteria are based on studies conducted in the Pacific Northwest and may not reflect upper temperature limits of salmonids in the southern portion of their range. Salmonids in the warmer portion of their range may have local adaptations to their regional temperature.

There are no regional or Russian River-specific data to assess the effects of temperature on coho salmon, steelhead and Chinook salmon. Literature values from local watersheds were given preference. The evaluation criteria presented here are consistent with those developed by RWQCB (2000). The RWQCB reviewed the water quality objective for temperature in the Russian River basin to protect aquatic life, including listed species. This process included an in-depth analysis of salmonid water temperature tolerances.

The effect of temperature on a given life-history stage is quantified using scores from 0 to 5. Preferred temperatures are based on optimum ranges from the literature and are assigned a score of 5, while incipient lethal temperatures are given a score of 0. The distribution of scores between 0 and 5 are based either on literature values, or in cases where no literature values exist, are interpolated between known values. The distribution of criteria values are based on USFWS Habitat Suitability Index (HSI) curves to the extent feasible.

Evaluation criteria for temperature by species and life-history stage are summarized in Table 4-1.

Table 4-1 Evaluation Criteria for Temperature by Species and Life-History Stage

Coho Salmon

Score*	Nov 1 to Jan 31 Up Migration		Dec 1 to Feb 15 Spawning		Dec 1 to Mar 31 Incubation		All Year Rearing	
0		≤ 3.0		≤ 1.7		≤ 0.0		≤ 1.7
1	> 3.0	≤ 4.0	> 1.7	≤ 3.0	> 0.0	≤ 3.0	> 1.7	≤ 4.0
2	> 4.0	≤ 5.0	> 3.0	≤ 4.0	> 3.0	≤ 3.5	> 4.0	≤ 7.0
3	> 5.0	≤ 6.0	> 4.0	≤ 6.0	> 3.5	≤ 4.0	> 7.0	≤ 8.0
4	> 6.0	< 7.2	> 6.0	< 7.0	> 4.0	< 4.4	> 8.0	< 12.0
5	≥ 7.2	≤ 12.7	≥ 7.0	≤ 13.0	≥ 4.4	≤ 13.3	≥ 12.0	≤ 14.0
4	> 12.7	≤ 14.0	> 13.0	≤ 14.0	> 13.3	≤ 14.0	> 14.0	≤ 15.0
3	> 14.0	≤ 15.0	> 14.0	≤ 15.0	> 14.0	≤ 15.0	> 15.0	≤ 16.0
2	> 15.0	≤ 16.0	> 15.0	≤ 16.0	> 15.0	≤ 16.0	> 16.0	≤ 20.0
1	> 16.0	< 21.1	> 16.0	< 17.0	> 16.0	< 18.0	> 20.0	< 26.0
0	≥ 21.1		≥ 17.0		≥ 18.0		≥ 26.0	

Steelhead

Score*	Jan 1 to Mar 31 Up Migration		Jan 1 to Apr 30 Spawning		Jan 1 to May 31 Incubation		All Year Rearing	
0		≤ 4.0		≤ 4.0		≤ 1.5		≤ 0.0
1	> 4.0	≤ 5.0	> 4.0	≤ 5.0	> 1.5	≤ 3.0	> 0.0	≤ 2.0
2	> 5.0	≤ 6.0	> 5.0	≤ 6.0	> 3.0	≤ 4.5	> 2.0	≤ 4.0
3	> 6.0	≤ 7.0	> 6.0	≤ 7.0	> 4.5	≤ 6.0	> 4.0	≤ 8.0
4	> 7.0	< 7.8	> 7.0	< 7.8	> 6.0	< 7.8	> 8.0	< 12.8
5	≥ 7.8	≤ 11.0	≥ 7.8	≤ 11.1	≥ 7.8	≤ 11.1	≥ 12.8	≤ 15.6
4	> 11.0	≤ 13.0	> 11.1	≤ 14.0	> 11.1	≤ 13.0	> 15.6	≤ 18.0
3	> 13.0	≤ 15.0	> 14.0	≤ 16.0	> 13.0	≤ 15.0	> 18.0	≤ 20.0
2	> 15.0	≤ 17.0	> 16.0	≤ 18.0	> 15.0	≤ 17.0	> 20.0	≤ 22.0
1	> 17.0	< 21.1	> 18.0	< 20.0	> 17.0	< 20.0	> 22.0	< 23.9
0	≥ 21.1		≥ 20.0		≥ 20.0		≥ 23.9	

*The effect of temperature on a given life-history stage is quantified using scores from 0 to 5. Preferred temperatures are based on optimum ranges and are assigned a score of 5, while incipient lethal temperatures are given a score of 0. The distribution of scores between 0 and 5 are based either on literature values, or in cases where no literature values exist, are interpolated between known values.

Table 4-1 Evaluation Criteria for Temperature by Species and Life-History Stage (Continued)

Chinook Salmon								
Score*	Aug 15 to Jan 15 Up Migration		Nov 1 to Jan 31 Spawning		Nov 1 to Mar 31 Incubation		Feb 1 to Jun 30 Rearing	
0		≤ 0.8		≤ 1.0		≤ 1.0		≤ 1.0
1	> 0.8	≤ 3.0	> 1.0	≤ 2.5	> 1.0	≤ 2.0	> 1.0	≤ 4.0
2	> 3.0	≤ 5.2	> 2.5	≤ 3.5	> 2.0	≤ 3.0	> 4.0	≤ 6.0
3	> 5.2	≤ 7.9	> 3.5	≤ 4.5	> 3.0	≤ 4.0	> 6.0	≤ 8.0
4	> 7.9	< 10.6	> 4.5	< 5.6	> 4.0	< 5.0	> 8.0	< 12.0
5	≥ 10.6	≤ 15.6	≥ 5.6	≤ 13.9	≥ 5.0	≤ 12.8	≥ 12.0	≤ 14.0
4	> 15.6	≤ 17.0	> 13.9	≤ 14.5	> 12.8	≤ 14.2	> 14.0	≤ 17.0
3	> 17.0	≤ 18.4	> 14.5	≤ 15.2	> 14.2	≤ 15.0	> 17.0	≤ 20.0
2	> 18.4	≤ 19.8	> 15.2	≤ 16.0	> 15.0	≤ 15.8	> 20.0	≤ 23.0
1	> 19.8	< 21.1	> 16.0	< 16.7	> 15.8	< 16.7	> 23.0	< 26.0
0	≥ 21.1		≥ 16.7		≥ 16.7		≥ 26.0	

*The effect of temperature on a given life-history stage is quantified using scores from 0 to 5. Preferred temperatures are based on optimum ranges and are assigned a score of 5, while incipient lethal temperatures are given a score of 0. The distribution of scores between 0 and 5 are based either on literature values, or in cases where no literature values exist, are interpolated between known values.

References: Anonymous 1971; Bell 1986; Bjornn and Reiser 1991; Boles et al. 1988; Brett 1952, Brett et al. 1982; CDFG 1991; California Resources Agency 1989; Cramer 1992; Fryer and Pilcher 1974; Hallock *et al.* 1970; Hanel 1971; McMahon 1983; Myrick and Cech 2000, 2002; Raleigh et al. 1984; Rich 1987; Seymour 1956; Sullivan et al 2000; and USEPA 1974.

4.1.2 Dissolved Oxygen

Criteria for dissolved oxygen are presented in Table 4-2.

Table 4-2 Dissolved Oxygen Evaluation Criteria by Species and Life-History Stage

Coho Salmon				
Habitat Score	Nov 1 to Jan 31 DO (mg/l) Up migration	Dec 1 to Mar 31 DO (mg/l) Spawning/ incubation	All Year DO (mg/l) Rearing	Feb 1 to May 15 DO (mg/l) Down migration
5	6.5	11	8.0	8.0
4	6.0	9.5	6.5	6.0
3	5.5	8	6.0	5.5
2	5.2	7.5	5.2	5.2
1	4.8	4.5	4.5	4.6
0	< 4.8	< 4.5	3.0	3.0

Table 4-2 Dissolved Oxygen Evaluation Criteria by Species and Life-History Stage (Continued)

Steelhead

Habitat Score	Jan 1 to Mar 31 DO (mg/l) Up migration	Jan 1 to May 31 DO (mg/l) Spawning/ incubation	All Year DO (mg/l) Rearing	Mar 1 to Jun 30 DO (mg/l) Down migration (Juveniles)
5	6.5	9	8.0	8.0
4	6.0	7.3	6.5	6.0
3	5.5	6.5	6.0	5.5
2	5.2	5.9	5.2	5.2
1	4.8	5.4	4.5	4.6
0	< 4.8	< 5.0	3.0	3.0

Chinook Salmon

Habitat Score	Aug 15 to Jan 15 DO (mg/l) Up migration	Nov 1 to Mar 31 DO (mg/l) Spawning/ incubation	Feb 1 to Jun 30 DO (mg/l) Rearing	Feb 1 to Jun 30 DO (mg/l) Down migration
5	6.5	11	8.0	8.0
4	6.0	9.5	6.5	6.0
3	5.5	8	6.0	5.5
2	5.2	7.5	5.2	5.2
1	4.8	4.5	4.5	4.6
0	< 4.8	< 4.5	3.0	3.0

4.1.3 TURBIDITY

Table 4-3 presents evaluation criteria for effects of turbidity on juvenile salmonid rearing and migration.

Table 4-3 Evaluation Criteria for Turbidity

Score	Rearing Turbidity (NTU)	Juvenile Migration Turbidity (NTU)
5	< 10	< 25
4	10 – 15	25 – 50
3	15 – 25	50 – 60
2	25 – 50[1]	60 – 65
1	50 – 70[2]	65 – 70
0	> 70[3]	> 70

References:
[1]Sigler et al. 1984
[2]Berg and Northcote 1985
[3]Bisson and Bilby 1982

4.2 CRITERIA FOR FLOW-RELATED HABITAT

This section addresses flow-related physical habitats and criteria to evaluate those habitats.

Since existing habitat suitability information collected on the Russian River was more than 20 years old, an alternative approach was developed in consultation with NOAA Fisheries, CDFG, USACE, and SCWA.

4.2.1 PHYSICAL HABITAT

Criteria for flow-related habitat in Dry Creek and the Russian River are presented in Table 4-4 and Table 4-5. The rearing criteria are based in part on the flow-related habitat assessment conducted by SCWA, NOAA Fisheries, and CDFG in 2001 (ENTRIX, Inc. 2002b). Outside of the range of flows addressed in the rearing study, the criteria are based on knowledge of the system, and discussions with biologists familiar with the system. The flow criteria for spawning in the Russian River are also based in part on the rearing study. Flow criteria for upstream migration were not addressed in the flow-related habitat assessment. However, these evaluation criteria were also based on knowledge of the system, and discussions with biologists familiar with the system.

Table 4-4 Flow Evaluation Criteria for Dry Creek by Species and Life Stage

Coho Salmon	Nov 1 to Jan 31	Dec 1 to Feb 15	Feb 1 to Apr 30	All Year
Habitat Score*	Q (cfs) Upmigration	Q (cfs) Spawning	Q (cfs) Fry Rearing	Q (cfs) Juvenile Rearing
0	≤ 10	≤ 5	≤ 0	≤ 0
1	>10 ≤ 20	> 5 ≤ 20	> 0 ≤ 10	> 0 ≤ 10
2	> 20 ≤ 30	> 20 ≤ 30	> 10 ≤ 20	> 10 ≤ 25
3	> 30 ≤ 90	> 30 ≤ 45	> 20 ≤ 30	> 25 ≤ 45
4	> 90 ≤ 125	> 45 ≤ 60	> 30 ≤ 40	> 45 ≤ 60
5	> 125 ≤ 200	> 60 ≤ 80	> 40 ≤ 70	> 60 ≤ 85
4	> 200 ≤ 250	> 80 ≤ 100	> 70 ≤ 90	> 85 ≤ 100
3	> 250 ≤ 325	> 100 ≤ 125	> 90 ≤ 130	> 100 ≤ 120
2	> 325 ≤ 400	> 125 ≤ 250	> 130 ≤ 200	> 120 ≤ 200
1	> 400 ≤ 500	> 250 ≤ 800	> 200 ≤ 500	> 200 ≤ 500
0	> 500	> 800	> 500	> 500
Chinook Salmon	**Aug 15 to Jan 15**	**Nov 1 to Jan 31**	**Feb 1 to Apr 30**	**Apr 1 to Jun 30**
Habitat Score*	**Q (cfs) Upmigration**	**Q (cfs) Spawning**	**Q (cfs) Fry Rearing**	**Q (cfs) Juvenile Rearing**
0	≤ 10	≤ 5	≤ 0	≤ 0
1		> 5 ≤ 25	> 0 ≤ 10	> 0 ≤ 10
2	> 10 ≤ 45	> 25 ≤ 40	> 10 ≤ 20	> 10 ≤ 25
3	> 45 ≤ 60	> 40 ≤ 60	> 20 ≤ 30	> 25 ≤ 45
4	> 60 ≤ 90	> 60 ≤ 80	> 30 ≤ 45	> 45 ≤ 60
5	> 90 ≤ 125	> 80 ≤ 105	> 45 ≤ 60	> 60 ≤ 90
4	> 125 ≤ 200	> 105 ≤ 130	> 60 ≤ 90	> 90 ≤ 100
3	> 200 ≤ 325	> 130 ≤ 150	> 90 ≤ 110	> 100 ≤ 110
2	> 325 ≤ 400	> 150 ≤ 290	> 110 ≤ 150	> 110 ≤ 200
1	> 400 ≤ 500	> 290 ≤ 3000	> 150 ≤ 500	> 200 ≤ 500
0	> 500	> 3000	> 500	> 500
Steelhead	**Jan 1 to Mar 31**	**Jan 1 to Apr 30**	**Mar 1 to Jun 30**	**All Year**
Habitat Score*	**Q (cfs) Upmigration**	**Q (cfs) Spawning**	**Q (cfs) Fry Rearing**	**Q (cfs) Juvenile Rearing**
0	≤ 10	≤ 5	≤ 0	≤ 0
1	>10 ≤ 20	> 5 ≤ 20	> 0 ≤ 5	> 0 ≤ 5
2	> 20 ≤ 30	> 20 ≤ 30	> 5 ≤ 15	> 5 ≤ 15
3	> 30 ≤ 90	> 30 ≤ 60	> 14 ≤ 30	> 14 ≤ 30
4	> 90 ≤ 125	> 60 ≤ 80	> 30 ≤ 40	> 30 ≤ 40
5	> 125 ≤ 200	> 80 ≤ 110	> 40 ≤ 55	> 40 ≤ 55
4	> 200 ≤ 250	>110 ≤ 135	> 55 ≤ 70	> 55 ≤ 70
3	> 250 ≤ 325	> 135 ≤ 150	> 70 ≤ 90	> 70 ≤ 90
2	> 325 ≤ 400	> 150 ≤ 250	> 90 ≤ 110	> 90 ≤ 110
1	> 400 ≤ 500	> 250 ≤ 1300	> 110 ≤ 500	> 110 ≤ 500
0	> 500	> 1300	> 500	> 500

*The effect of temperature on a given life-history stage is quantified using scores from 0 to 5. Preferred temperatures are based on optimum ranges and are assigned a score of 5, while incipient lethal temperatures are given a score of 0. The distribution of scores between 0 and 5 are based either on literature values, or in cases where no literature values exist, are interpolated between known values.

Table 4-5 Flow Evaluation Criteria for Mainstem Russian River by Species and Life Stage

Coho Salmon	**Nov 1 to Jan 31**			
Habitat Score*	**Q (cfs) Upmigration**			
0	≤ 50			
1	> 50 ≤ 75			
2	> 75 ≤ 100			
3	>100 ≤ 125			
4	> 125 ≤180			
5	> 180 ≤ 400			
4	> 400 ≤ 800			
3	> 800 ≤ 2000			
2	> 2000 ≤ 4000			
1	> 4000			
0				
Chinook Salmon	**Aug 15 to Jan 15**	**Nov 1 to Jan 31**	**Feb 1 to Apr 30**	**Apr 1 to Jun 30**
Habitat Score*	**Q (cfs) Upmigration**	**Q (cfs) Spawning**	**Q (cfs) Fry Rearing**	**Q (cfs) Juvenile Rearing**
0	≤ 50	≤ 25	≤ 0	≤ 0
1	> 50 ≤ 75	> 25 ≤ 100	> 0 ≤ 20	> 0 ≤ 20
2	> 75 ≤ 100	> 100 ≤ 130	> 20 ≤ 40	> 20 ≤ 50
3	>100 ≤ 125	> 130 ≤ 150	> 40 ≤ 80	> 50 ≤ 100
4	> 125 ≤180	> 150 ≤ 190	> 80 ≤ 115	> 100 ≤115
5	> 180 ≤ 400	> 190 ≤ 210	> 115 ≤ 135	> 115 ≤ 145
4	> 400 ≤ 800	> 210 ≤ 300	> 135 ≤ 175	> 145 ≤ 190
3	> 800 ≤ 2000	> 300 ≤ 400	> 175 ≤ 250	> 190 ≤ 275
2	> 2000 ≤ 4000	> 400 ≤ 700	> 250 ≤ 500	> 275 ≤ 1000
1	> 4000	> 700 ≤ 2500	> 500 ≤ 1500	> 1000 ≤ 2500
0		> 2500	> 1500	> 2500
Steelhead	**Jan 1 to Mar 31**	**Jan 1 to Apr 30**	**Mar 1 to Jun 30**	**All Year**
Habitat Score*	**Q (cfs) Upmigration**	**Q (cfs) Spawning**	**Q (cfs) Fry Rearing**	**Q (cfs) Juvenile Rearing**
0	≤ 50	≤ 25	≤ 0	≤ 0
1	> 50 ≤ 75	> 25 ≤ 70	> 0 ≤ 20	> 0 ≤ 20
2	> 75 ≤ 100	> 70 ≤ 100	> 20 ≤ 40	> 20 ≤ 50
3	>100 ≤ 125	> 100 ≤ 130	> 40 ≤ 80	> 50 ≤ 80
4	> 125 ≤180	> 130 ≤ 180	> 80 ≤ 100	> 80 ≤ 115
5	> 180 ≤ 400	> 180 ≤ 200	> 100 ≤ 125	> 115 ≤ 145
4	> 400 ≤ 800	> 200 ≤ 250	> 125 ≤ 150	> 145 ≤ 190
3	> 800 ≤ 2000	> 250 ≤ 350	> 150 ≤ 200	> 190 ≤ 275
2	> 2000 ≤ 4000	> 350 ≤ 700	> 200 ≤ 500	> 275 ≤ 1000
1	> 4000	> 700 ≤ 2500	> 500 ≤ 1500	> 1000 ≤ 2500
0		> 2500	> 1500	> 2500

*The effect of temperature on a given life-history stage is quantified using scores from 0 to 5. Preferred temperatures are based on optimum ranges and are assigned a score of 5, while incipient lethal temperatures are given a score of 0. The distribution of scores between 0 and 5 are based either on literature values, or in cases where no literature values exist, are interpolated between known values.

4.2.2 Flood Control Releases

The USACE determines releases from WSD and CVD from the flood control pool of the reservoirs. The magnitude and frequency of flow releases during flood control operations affect channel geomorphology, scour of spawning gravels, and the extent of bank erosion.

To evaluate the effects of flood control operations on channel geomorphology, streamflow conditions were represented with hydraulic models instead of with historic streamflow data. Two streamflow models, the SCWA model and the USACE HEC-5 model, were combined to most accurately simulate historic flow conditions. The combined flow model results are simply referred to as the hydrologic model.

4.2.2.1 Scour of Spawning Gravels Evaluation Criteria

The flow ranges at which spawning gravel motion is initiated for various streams and stream reaches were modeled in *Interim Report 1* (ENTRIX, Inc. 2000a).

The evaluation system shown in Tables 4-6 to 4-7 is based on the number of cross-sections that will initiate bed movement within each of the stream reaches evaluated. As flows increase and more cross-sections experience bed movement, scores are lower. To the extent feasible, the ordinal ranking scores are lowered by 1 at approximately every 20 to 25 percent incremental change in the number of cross-sections moved.

Dry Creek Evaluation Criteria

Table 4-6 Evaluation Criteria for Scour of Coho Salmon Redds in Dry Creek

Flow Range	Coho Salmon Dec.1-Jan.31 (before spawning is over)	Coho Salmon Feb.1-Feb.28 (incubation)
<800 cfs	5	5
>800-1,400 cfs	4	3
>1,400-3,000 cfs	3	2
>3,000-8,700 cfs	2	1

Table 4-7 Evaluation Criteria for Scour of Chinook Salmon Redds in Dry Creek

Flow Range	Chinook Salmon Nov 1-Jan 31 (before spawning is over)	Chinook Salmon Feb 1-Mar 31 (incubation)
<3,000 cfs	5	5
>3,000-6,000 cfs	4	3
>6,000-9,000 cfs	3	2
>9,000-15,000 cfs	2	1

Table 4-8 Evaluation Criteria for Scour of Steelhead Redds in Dry Creek

Flow Range	Steelhead Dec 1-April 30 (before spawning is over)	Steelhead May 1-May 31 (incubation)
<1,300 cfs	5	5
>1,300-2,600 cfs	4	3
>2,600-5,500 cfs	3	2
>5,500-12,000 cfs	2	1

Mainstem Russian River in Alexander Valley

Since coho salmon do not utilize the mainstem Russian River for spawning, only scour of Chinook salmon and steelhead spawning gravels were evaluated.

Table 4-9 Evaluation Criteria for Scour of Chinook Salmon Redds in Alexander Valley

Flow Range	Chinook Salmon Nov.1-Jan.31 (before spawning is over)	Chinook Salmon Feb.1-Mar.31 (incubation)
<5,000 cfs	5	5
>5,000-18,000 cfs	4	3
>18,000-27,000 cfs	3	2

Table 4-10 Evaluation Criteria for Scour of Steelhead Redds in Alexander Valley

Flow Range	Steelhead Dec.1-April30 (before spawning is over)	Steelhead May1-May31 (incubation)
<2,000 cfs	5	5
>2,000-5,000 cfs	4	3
>5,000-12,000 cfs	3	2
>12,000-24,000 cfs	2	1

Table 4-11 Evaluation Criteria for Scour of Chinook Salmon Redds in the Upper Mainstem Russian River

Flow Range	Chinook Salmon Nov.1-Jan.30 (before spawning is over)	Chinook Salmon Feb.1-Mar.30 (incubation)
<1,000 cfs	5	5
>1,000 cfs	4	3

Table 4-12 Evaluation Criteria for Scour of Chinook Salmon Redds in the Upper Mainstem Russian River

Flow Range	Steelhead Dec.1-April30 (before spawning is over)	Steelhead May1-May30 (incubation)
<500 cfs	5	5
>500 cfs	4	3

Since the impact of flood control operations from CVD is insignificant below Healdsburg, and spawning is not considered to be significant on the lower mainstem reach, no analysis was performed below Alexander Valley.

4.2.2.2 Bank Erosion Evaluation Criteria

The flow threshold at which bank erosion is estimated to occur in Dry Creek is 2,500 cfs. Evaluation criteria for streambank stability for Dry Creek are based on the percentage of time during each water year that exceeds 2,500 cfs (Table 4-13).

Table 4-13 Evaluation Criteria for Dry Creek Streambank Stability

Percent of Time Flows Greater than 2,500 cfs	Number of Days per Year	Score
<1%	3 or less	5
1%-2%	4-7	4
>2%-3%	8-11	3
>3%-4%	12-15	2
>4%	16 or more	1

The flow threshold at which bank erosion occurs on the mainstem Russian River has not been specified. Therefore, the same unregulated recurrence-interval flood that initiates bank erosion on Dry Creek was used to evaluate bank erosion on the mainstem downstream of CVD. Evaluation criteria for Hopland and Cloverdale are shown in Table 4-14. Streambank erosion was not considered further downstream because the ability to control flood flows becomes greatly diminished at Healdsburg.

Table 4-14 Evaluation Criteria for Mainstem Russian River Streambank Stability

Percent of time flows >6,000 cfs at Hopland and >8,000 cfs at Cloverdale	Number of days per year	Score
<1%	3 or less	5
1%-2%	4-7	4
>2%-3%	8-11	3
>3%-4%	12-15	2
>4%	16 or more	1

4.2.2.3 Maintenance of Channel Geomorphology Evaluation Criteria

Geomorphic conditions are maintained by the channel-forming, 1.5-year annual maximum flood flow, shown in Table 4-15. Hydrologic modeling provides a simulated representation of average daily flow for the period of record to estimate channel-forming flow.

Table 4-15 Channel-Maintenance Flow Associated with the 1.5-Year Peak Discharge and 1.5-Year One-Day Discharge

	1.5-Year Peak Discharge	1.5-Year One-Day Discharge
Dry Creek below Warm Springs Dam	9,500	5,000
Dry Creek near Geyserville	11,000	7,000
Russian River at Hopland	14,500	9,500
Russian River at Cloverdale	18,000	14,000
Russian River at Healdsburg	25,000	21,000

Evaluation criteria based on the frequency of channel-forming flows are shown in Table 4-16. The evaluation applies equally to coho salmon, steelhead, and Chinook salmon.

Table 4-16 Evaluation Criteria for Maintenance of Channel Geomorphic Conditions

Proportion of Years with Channel Maintenance Flows	Number of Years per 36-Year Period of Record[a]	Score
51%-66%	19-24	**5**
36%-50%	14-18	**4**
21%-35%	8-13	**3**
11%-20%	5-7	**2**
1%-10%	4 or less	**1**
0%	0	**0**

[a]Multiple channel-forming flows that may occur in a single year are counted as one occurrence for that year.

4.2.3 Fish Stranding

If ramping rates (rate of change in flow releases from a dam) during dam maintenance or flood control operations are too high, flow recessions can strand fish. Fry are more susceptible than juvenile fish. Table 4-17 shows the periods when salmonid fry may be present.

Table 4-17 Times When Fry May Be Present in the Russian River Drainage

Species	Emergence	Fry May Be Present
Coho Salmon	Feb. 1 - Mar. 31	Feb. - April
Steelhead	Mar. 1 - May 31	Mar. - June
Chinook Salmon	Feb. 1 - Mar. 31	Feb. - April

The Washington Department of Fisheries has proposed rate-of-stage change that will generally protect fish (Hunter 1992). Hunter's ramping guidelines are modified based on the phenology of salmonids in the Russian River for this assessment (Table 4-18).

Table 4-18 Rate-of-Stage Change Based upon Hunter (1992) and Life-History Stages for Salmon and Steelhead in the Russian River

Season	Rates
March 1 to July 1	1 inch/hour (0.08 feet/hour)
June 1 to November 1	2 inches/hour (0.16 feet/hour)

During juvenile rearing periods, which occur year round for steelhead and coho salmon in the Russian River and Dry Creek, a 2 inch/hour (0.16 ft/hr) stage change is appropriate, based on Hunter's proposed guidelines.

4.2.3.1 Flood Control Operations

USACE, in consultation with NOAA Fisheries and CDFG, has developed interim guidelines for flow-release changes in the Russian River and Dry Creek, as follows:

Reservoir Outflow	Ramping Rate
25-250 cfs	125 cfs/h
250-1,000 cfs	250 cfs/h
>1,000 cfs	1,000 cfs/h

It is unlikely that ramping-up rates associated with flood control operations would affect listed species because project operations have a small effect compared to natural flow during storm events. Therefore, evaluation criteria have not been developed.

Ramping Release Rate 1,000 cfs to 250 cfs

Evaluation criteria and scoring for ramping in the 1,000 cfs to 250 cfs flow range (Table 4-19) are based on Hunter's (1992) guidelines and the interim ramping rates established by USACE in consultation with NOAA Fisheries and CDFG.

Table 4-19 Ramping Evaluation Criteria for Releases of 1,000 cfs to 250 cfs

Category Score	Evaluation Criteria Category
5	Meets 0.16 ft Maximum Stage Change.
4	Within 100% of 0.16 ft Criteria (0.32 ft) for Stage Change.
3	Meets Interim Ramping Criteria (250 cfs/h).
2	Exceeds Interim Ramping Criteria up to 50% (375 cfs/h).
1	Exceeds Interim Ramping Criteria by Greater than 50% (>375 cfs/h).

Ramping Release Rate 250 cfs to 25 cfs

Ramping of release flows in the range of 250 cfs to 25 cfs typically takes place in winter or spring as flood control operations reduce flows from much higher rates following storm events (Table 4-20).

Table 4-20 Ramping Evaluation Criteria for Releases of 250 cfs to 25 cfs[1]

Category Score	Evaluation Criteria Category
5	Meet 0.16 ft Maximum Stage Change.
4	Within 100% of 0.16 ft Criteria (0.32 ft) for Stage Change.
3	Meets Interim Ramping Criteria (125 cfs/h).
2	Exceeds Interim Ramping Criteria up to 50% (188 cfs/h).
1	Exceeds Interim Ramping Criteria by greater than 50% (>188 cfs/h).

[1]Minimum flows below CVD and WSD are 25 cfs. Only during maintenance activities do releases approach 0 cfs. Bypass flows of 25 cfs would be provided during maintenance.

4.2.3.2 Annual and Periodic Dam Inspections and Maintenance

In addition to ramping during flood control operations, change in flow releases from WSD and CVD occur for annual dam maintenance and inspection activities. The ramping rate at WSD for inspection is typically 25 cfs/h. At CVD, the typical ramping rate has been 50 cfs/h.

Evaluation criteria for ramping during pre-flood inspections are based on documented rates of stranding downstream of WSD and CVD during maintenance activities, and on hydraulic modeling that estimates stage changes associated with ramping rates (Table 4-21). These criteria are applied at CVD only when streamflows are less than 500 cfs at the Ukiah gage.

Table 4-21 Evaluation Criteria for Low Storage Reservoir Outflows (250 cfs to 0 cfs)[1] during Dam Maintenance and Pre-Flood Inspection Periods

Change in Flow (cfs/h)	Score Juvenile	Score Fry
0-10	5	5
10-20	5	4
20-30	4	3
30-40	3	2
40-50	2	1
>50	1	0

[1]Only during maintenance activities do releases approach 0 cfs. Bypass flows of 25 cfs would be provided during maintenance.

To assess the effects of deflation of the inflatable dam at Mirabel, evaluation criteria were developed in three components. These include: 1) the effects of ramping rate and stage change for juvenile and adult salmonids (Table 4-22) and for fry (Table 4-23);
2) stranding or displacement due to habitat features in the affected area (Table 4-24); and
3) stranding or displacement due to frequency of flow recessions (Table 4-25).

Table 4-22 Ramping and Stage Change Evaluation Criteria for Juvenile and Adult Salmonids

Category Score	Evaluation Criteria Category
5	Meets 0.16 ft/hr maximum stage change.
4	Meets 0.32 ft/hr maximum stage change.
3	Meets 0.48 ft/hr maximum stage change.
2	Meets 1.4 ft/hr maximum stage change.
1	Greater than 1.4 ft/hr maximum stage change.

Table 4-23 Ramping and Stage Change Evaluation Criteria for Fry

Category Score	Evaluation Criteria Category
5	Meets 0.08 ft/hr maximum stage change.
4	Meets 0.16 ft/hr maximum stage change.
3	Meets 0.32 ft/hr maximum stage change.
2	Meets 0.48 ft/hr maximum stage change.
1	Greater than 0.48 ft/hr maximum stage change.

Table 4-24 Habitat/Flow Recession Interaction Evaluation Criteria for Fry, Juvenile, and Adult Salmonids

Category Score	Evaluation Criteria Category
5	Habitat features unlikely to induce stranding.
4	Few habitat features present to induce stranding.
3	Some habitat features that induce stranding, but area affected is small (<30%).
2	Many habitat features that induce stranding, but area affected is small (<30%).
1	Some habitat features that induce stranding, area affected is large (>30%).
0	Many habitat features that induce stranding, area affected is large (>30%).

Table 4-25 Flow Reduction Frequency Evaluation Criteria for Fry, Juvenile, and Adult Salmonids

Category Score	Evaluation Criteria Category
5	Less than two fluctuations per year in critical habitat.
4	Between three and nine fluctuations per year in critical habitat.
3	Between 10 and 29 fluctuations per year in critical habitat.
2	Between 30 and 100 fluctuations per year in critical habitat.
1	More than 100 fluctuations per year in critical habitat.
0	Daily fluctuations in critical habitat.

4.2.4 Fish-Passage

Two sets of evaluation criteria related to fish passage are presented. The first evaluates the effectiveness of fish-passage structures (fish ladders or restoration actions that improve fish passage). The second evaluates fish passage past diversion facilities.

4.2.4.1 Fish-Passage Structures

Fish-passage structures are usually required when anthropogenic structures, such as culverts or dams, block spawning runs. As structures have the potential to affect the risk of predation on juvenile fish, evaluation criteria for predation are presented in the following section.

4.2.4.2 Evaluation Criteria for Fish-Passage Design

Evaluation criteria for adult fish passage are based on the effectiveness of the fish-passage design (Table 4-26).

Table 4-26 Adult Fish-Passage Evaluation Criteria Based on Fish-Ladder Design and Operation

Category Score	Evaluation Categories
5	Fish passage passes adult salmonids without delay.
4	Fish passage passes adult salmonids with acceptable delay.
3	Fish passage passes all target species after extended delay.
2	Fish passage does not pass all target species of adult salmonids.
1	Passage provided but does not appear to pass any adult salmonids; or passage not provided.

4.2.4.3 Fish Passage Past Diversion Facilities

Fish screens were evaluated according to their performance standards and ability to pass juvenile and fry-sized salmonids within NOAA Fisheries criteria (Table 4-27).

Table 4-27 Juvenile Salmonids Passage Evaluation Criteria for Screen Design

Category Score	Evaluation Category
5	Fish screens meet NOAA Fisheries criteria and pass fish without injury or delay.
4	Facility provided with fish screens, but the facility has a low risk of entrainment, impingement, or migration delay.
3	Facility provided with fish screens, but the facility has a moderate risk of entrainment, impingement, or migration delay; effective rescue or escape is provided.
2	Facility provided with fish screens, but the facility has a high risk of entrainment, impingement, or migration delay; ineffective rescue or escape is provided.
1	Facility not provided with fish screens; no rescue or escape is provided.

For a screened diversion facility that meets NOAA Fisheries criteria, or has a low risk of entrainment, impingement, or migration delay, no further evaluation is required. For a diversion facility not screened or has screens that do not meet NOAA Fisheries criteria, additional criteria are presented to evaluate the level of risk to salmonids. Fish passage at a diversion facility was also evaluated for the risk of entrapment, impingement, or injury to listed species based on the proportion of surface water diverted (Table 4-28), and the degree of overlap between the migration period and the period of diversion operation (Table 4-29).

Table 4-28 Passage Evaluation Criteria for Juvenile Salmonids – Opportunity for Entrapment, Impingement, or Injury during Operation – Amount of Water Diverted

Category Score	Evaluation Category
5	Facility does not affect any surface-water flow.
4	Facility diverts less than 25% of surface-water flow.
3	Facility diverts between 25-50% of surface-water flow.
2	Facility diverts between 50-75% of surface-water flow.
1	Facility diverts more than 75% of surface-water flow.

Table 4-29 Passage Evaluation Criteria for Juvenile Salmonids – Opportunity for Entrapment, Impingement, or Injury – Time Water is Diverted

Category Score	Evaluation Category
5	Facility does not affect surface-water flow during any time of migration period.
4	Facility diverts surface-water flow during less than 10% of migration period.
3	Facility operates between 10 and 15% of migration period.
2	Facility operates between 15 and 25% of migration period.
1	Facility operates during more than 25% of the migration period.

4.3 CRITERIA FOR PREDATION

Piscivorous fish species in the Russian River watershed that may prey on listed fish species include non-native largemouth and smallmouth bass, green sunfish, and native Sacramento pikeminnow (Moyle 2002). Evaluation criteria for increased risk of predation on listed fish species were developed in three components including: structural criteria (Table 4-30), access criteria (Table 4-31), and habitat criteria (Table 4-32).

Table 4-30 Predation Evaluation Criteria: Component 1 – Structural Criteria

Category Score	Evaluation Criteria
5	No features that concentrate salmonids or provide cover for predators, concentrations of predators not found.
4	No features that concentrate salmonids, predator cover near, predators in low abundance locally.
3	Features that concentrate salmonids, no predator cover nearby, predators in medium to low abundance locally.
2	Features that concentrate salmonids, predator cover nearby, predators in medium to low abundance locally.
1	Features that highly concentrate salmonids, predators abundant locally.

Table 4-31 Predation Evaluation Criteria: Component 2 – Access Criteria

Category Score	Evaluation Criteria
5	Structure does not allow passage of predators; predators not present near structure.
4	Structure does not allow passage of predators; predators present near structure.
3	Structure provides limited passage of predators, or limited passage to areas where they are already well-established; predators not present near structure.
2	Structure provides limited passage of predators to areas where they have historically not been found or have been found in limited numbers; predators present in limited numbers near structure.
1	Structure provides passage of predators to areas they have historically not been found or found in limited numbers; predators present or migrate to structure.

Table 4-32 Predation Evaluation Criteria: Component 3 – Warmwater Species Temperature Criteria

Category Score	Evaluation Criteria
5	Water temperatures < 13ºC
4	Water temperatures 13 - 18ºC
3	Water temperatures 18 - 20ºC
2	Water temperatures 20 - 22ºC
1	Water temperatures 22 - 24ºC
0	Water temperatures ≥ 24ºC

4.4 CRITERIA FOR IN-CHANNEL AND STREAMBANK ACTIVITIES

Channel maintenance activities, such as streambank and streambed stabilization, sediment maintenance, debris removal, and vegetation control, have the potential to affect salmonid habitat. Long-term effects may include increased sediment deposition and turbidity. Immediate, direct effects may include direct injury to fish or incubating eggs.

4.4.1 VEGETATION CONTROL

Vegetation may be removed from streambanks and stream-channel bottoms to maximize channel-flow capacity and to reduce the risk of fires. Non-native vegetation removal may be conducted as part of a restoration action. Both direct and indirect effects of vegetation control are evaluated.

4.4.1.1 Direct Effects of Vegetation Control

The vegetation control evaluation criteria (Table 4-33) assess the amount and quality of chemicals released into the aquatic environment when herbicides are used.

Table 4-33 Evaluation Criteria for Vegetation Control Associated with Herbicide Use

Category Score	Evaluation Criteria Category
5	No chemical release.
4	Limited use of herbicide approved for aquatic use in riparian zones or over water.
3	Moderate to heavy use of herbicide approved for aquatic use in riparian zones or over water.
2	Use of herbicide not consistent with instructions.
1	Use of herbicide not approved for aquatic use in riparian zones or over water.

4.4.1.2 Indirect Effects of Vegetation Control

Evaluation criteria for vegetation control in constructed flood control channels are based on the extent of removal of native riparian vegetation (Table 4-34). Higher scores are associated with activities that preserve or increase a riparian corridor composed of native species. Lower scores are given for maintenance practices that result in removal of riparian vegetation.

Table 4-34 Vegetation Control Evaluation Criteria for Flood Control Channels

Category Score	Evaluation Criteria Category
5	No removal except selectively along access roads, fencelines, “spot” treatments, or to remove non-native species.
4	< 25% reduction in native vegetation.
3	>25% to < 50% reduction in native vegetation.
2	>50% to <75% reduction in native vegetation.
1	>75% reduction in native vegetation.

Evaluation criteria for vegetation control in natural channels are based on the extent of removal of native riparian vegetation and differ from those for flood-control channels (Table 4-35).

Qualitative evaluation of vegetation maintenance will also be made, based on the extent and frequency of maintenance, and observations of existing aquatic habitat.

Table 4-35 Vegetation Control Evaluation Criteria for Natural Channels

Category Score	Evaluation Criteria Category
5	No vegetation removal except “spot” treatment, or removal of only non-native species.
4	<10% reduction in native vegetation.
3	>10% to <25% reduction in native vegetation.
2	>25% to <50% reduction in native vegetation.
1	>50% reduction in native vegetation.

4.4.2 STREAMBANK AND STREAMBED STABILIZATION

Qualitative evaluation of maintenance of streambank stabilization structures is based on the extent to which maintenance of bank stabilization structures reduce overstory canopy cover (shading), in-channel cover (undercut banks, exposed root wads, backwater areas), and gravel recruitment.

4.4.2.1 Russian River

Evaluation of streambank stabilization activities on habitat in the Russian River is based on a qualitative assessment that considers the extent and frequency of maintenance actions, protocols implemented, and observations of existing aquatic habitat and geomorphic conditions.

4.4.3 SEDIMENT MAINTENANCE

Habitat effects from sediment maintenance activities may include:

- increased water temperatures and reduced cover if riparian vegetation is removed or disturbed.
- reduced supply of spawning gravels.
- change in channel geomorphology that may result in various habitat effects such as alteration of fish-passage conditions, reduced channel sinuosity that limits pool and rearing habitat, and reduced high-flow refuge.
- general loss of hydraulic and associated aquatic habitat complexity depending upon the type of habitat conditions normally present in the project reach.

Long-term changes to critical habitat for salmonids may occur due to sediment maintenance, but these effects could be either positive or negative. Qualitative evaluation of sediment removal effects in flood control channels is based on observations of changes in channel geomorphic and habitat conditions prior to and following excavation activities in 2000 and 2001.

4.4.4 DEBRIS CLEARING

Evaluation criteria for LWD removal are presented in Table 4-36.

Table 4-36 Large Woody Debris Removal

Category Score	Evaluation Criteria Category
5	No LWD removal.
4	LWD not removed, but modified.
3	LWD removal limited to only when it poses a flood-control hazard; removal does not result in substantial reduction of cover or scour in the area.
2	LWD removal limited, but potentially results in moderate reduction of cover or scour.
1	Complete removal of LWD resulting in substantial reduction of cover or scour.

4.4.5 SEDIMENT CONTAINMENT

Evaluation criteria for sediment control during construction and maintenance activities address two components: instream and upslope sediment control (Table 4-37).

Table 4-37 Sediment Containment Evaluation Criteria

Category Score	Evaluation Criteria Category
	Component 1: Instream sediment control
5	Project area does not require rerouting streamflow.
4	Clean bypass or similar method used.
3	Effective instream sediment control (e.g., berm/fence).
2	Limited sediment control.
1	No instream sediment control.
	Component 2: Upslope sediment control
5	No upslope disturbance, or an increase in upslope stability.
4	Limited disturbance with effective erosion control measures.
3	Moderate to high level of disturbance with effective erosion control measures.
2	Action likely to result in increase in sediment input into stream.
1	Action likely to result in slope failure, bank erosion, an uncontrolled sediment .input to the channel, or major changes in channel morphology.

4.4.6 INJURY TO FISH

Work in a streambed that has flowing water or standing pools may result in direct injury or mortality to fish or incubating eggs. Immediate, direct effects from construction or maintenance activities are scored according to the opportunity for injury to listed species (Table 4-38).

Table 4-38 Opportunity for Injury-Evaluation Criteria

Category Score	Evaluation Criteria Category
5	Project area is not within flood plain or below maximum water surface elevation, and requires no isolation from flow.
4	Project area is within dry part of channel, or construction and maintenance activity scheduled when species of concern is not present.
3	Appropriate BMPs are applied; e.g., project area survey, escape, or rescue provided; project area isolated from flow (if appropriate).
2	Limited ability to apply appropriate BMPs.
1	Appropriate BMPs are not applied.

4.5 CRITERIA RELATED TO RESTORATION AND CONSERVATION ACTIONS

The biological value of specific SCWA restoration projects are assessed according to components that are presented in Table 4-39. Each project is evaluated for each of the target species, and for spawning/incubation, rearing, or migration life-history stages.

Table 4-39 Components Considered in Determining the Biological Benefit of a Restoration Project

Component	Description
Size	Length of stream affected. Downstream or upstream habitat may also be affected. For example, streambank erosion control is likely to reduce sedimentation of downstream habitat, or installation of fish passage may result in access to miles of upstream spawning and rearing habitat.
Time	The time-frame for expected benefits. Projects with rapid start-up times may have a greater beneficial effect. Some projects may take some time before benefits are fully realized, but if they are of long duration or permanent in nature, substantial benefits can be realized for listed fish species.
Habitat Elements	A qualitative assessment of the habitat elements affected and their relative importance to listed fish species.
Habitat or Population Data	If data are available on population abundance or stream assessments, they are used to assess the relative importance of the project to listed fish species. For example, a fish-passage project that provides access to several miles of high-quality spawning and rearing habitat may have more value than instream habitat improvements in an area that is likely to have limited rearing or spawning habitat. If a known limiting factor is addressed, the project is considered to have a higher benefit.
Cost	Limited public and private funds are available for restoration actions. Projects that can deliver the most benefit for these dollars are preferred alternatives.
Education	A project that has an educational component or can serve as a demonstration project may have indirect beneficial effects.

A restoration project may improve the quantity and/or quality of the habitat or it may produce no change (Table 4-40).

Table 4-40 Biological Benefit Evaluation Criteria for Restoration Actions

Category Score	Evaluation Criteria Category
5	Very high potential to benefit.
4	High potential to benefit.
3	Moderate potential to benefit.
2	No benefit and utilizes scarce resources.
1	Poorly planned or implemented, degrades habitat.

Watershed management projects include three general categories of projects: 1) data collection, 2) demonstration projects, and 3) information coordination and dissemination.

4.6 Criteria for Monitoring Programs and Data Collection

Biological data are essential to recovery of listed species and protection of their habitat. Studies funded, coordinated, or implemented by SCWA produce information that is essential for effective and cost-efficient restoration and conservation activities. Types of information that can be gathered from these studies include:

- Habitat data
- Fish population data
- Invasive plant species information
- Demonstration project results

4.6.1 Information Value

Evaluation criteria for information gathering or dissemination assess the extent of the geographic area in which the information is to be used. A qualitative assessment is made on the relative biological benefit to listed species or designated critical habitat (Table 4-41).

Table 4-41 Information Value Evaluation Criteria

Category Score	Evaluation Criteria Category
5	Basin-wide applicability.
4	A region or "type" of habitat (*i.e.*, small tributaries, or lower mainstem).
3	Isolated project/stream information.
2	Information not useful to listed species or critical habitat.
1	Incorrect or misleading information.

4.6.2 Information Coordination and Dissemination

The Russian River basin will be subjected to increasing demands on its resources. If the basin is to be protected and restored to the fullest extent possible, coordination among stakeholders is essential. By coordinating with agencies, government entities, and various organizations or watershed groups, limited resources can be put to maximum use. Monitoring and assessment programs will be evaluated relative to their applicability to other programs. However, some monitoring programs may be limited in scope, but provide critical data to assess a specific effect.

4.7 CRITERIA FOR FISH PRODUCTION

This section identifies the potential effects that fish production facilities may have on listed fish species and their habitats, including: 1) water quality, and 2) listed fish populations, including genetic and ecological risks.

4.7.1 WATER QUALITY COMPLIANCE

Most fish production facilities divert water into the facility with subsequent discharge back to the river. The permits require that the facilities be equipped with waste-treatment equipment to insure compliance with specified water-quality criteria (Table 4-42).

Table 4-42 Discharge Standards for DCFH and CVFF

Parameter	Effluent Limit (Daily Maximum)
Total Suspended Solids	15 mg/l
Total Settleable Solids	0.2 ml/1/hr
pH	Within 0.5 of receiving waters
Salinity (chloride)	250 mg/l
Temperature	no measurable change to receiving water
Turbidity	no increase > 20% of background
Dissolved Oxygen	> 7.0 mg/l
Flow – DCFH	15.5 mgd
Flow – CVFF	7.11 mgd

The discharge permits include stipulations in addition to the monthly monitoring noted above. Evaluation criteria for water-quality effects are presented in Table 4-43, providing five categories of effects that relate to routine compliance with NPDES requirements.

Table 4-43 Water Quality Compliance Evaluation Criteria

Category Score	Evaluation Criteria Category
5	Continuous compliance with NPDES standards.
4	Compliance with 75-99% of standards.
3	Compliance with 50-74% of standards.
2	Compliance with 25-49% of standards.
1	Compliance with 0-24% of standards.

4.7.2 GENETIC AND ECOLOGICAL RISKS

In general, the potential risks of hatchery production on listed fish species can be categorized into two areas: genetic risks and ecological risks. Table 4-44 provides a cross-reference index that associates the risk issues to the various hatchery operations that may affect those risks. The seven hatchery operations that may affect each risk are described in detail in the next section.

Table 4-44 Risks to Wild Salmonids from Hatchery Production and the Associated Hatchery Operations that May Affect Each Risk

Risks to Wild Salmonids Associated with Hatchery Production	Hatchery Operations that May Affect Each Risk						
	Source of Broodstock	**Numbers of Broodstock Collected**	**Broodstock Sampling and Mating**	**Rearing Techniques**	**Release Strategies**	**Duration in Hatchery Captivity**	**Harvest Management**
Genetic Risks							
Loss of Diversity							
Within Population Diversity	X	X	X	X		X	
Between Population Diversity	X				X		
Outbreeding Depression	X		X				
Inbreeding Depression	X	X					
Ecological Risks							
Competition					X		
Predation					X		
Disease Transfer				X			
Outmigration Behavior					X		
Long-term Viability				X			
Artificial Selection	X			X		X	
Disproportional Survival		X	X				
Harvest Bycatch							X

Genetic risks that may occur as a result of hatchery operations include:

- Loss of within-population diversity
- Loss of between-population diversity
- Outbreeding depression
- Intrinsic co-adaptation (Epistasis)
- Extrinsic coadaptation

- Outbreeding depression due to disruption of local adaptation
- Inbreeding depression

Ecological risks that may occur as a result of hatchery operations include:

- Competition
- Predation
- Disease transfer
- Outmigration behavior
- Long-term viability
- Artificial selection
- Disproportional survival
- Harvest bycatch

4.7.3 Evaluation Criteria for Genetic and Ecological Risks

This section provides the analysis approach that is used to assess these risks. Due to the diversity of hatchery operations, this discussion is organized into seven categories that encompass functional requirements. Following each hatchery operations category, a table is presented that ranks the risk of various hatchery practices. The evaluation will focus on the process of implementing the most effective management approach for achieving recovery of listed fish species.

4.7.3.1 Sources of Broodstock

An isolated harvest program would derive all broodstock from the supply of adult salmonids returning to the hatchery. For supplementation and integrated harvest programs, the annual source of broodstock would come from the wild population, wherever possible. The selection of a broodstock source for a supplementation or integrated harvest program ultimately will be dictated by availability.

Table 4-45 organizes the recommended priorities for broodstock source into five categories and provides each category with a score of relative risk level.

Table 4-45 Source of Broodstock Evaluation Criteria

Category Score	Evaluation Criteria Categories
5	Local broodstock source (target stock), collected in the most unbiased manner possible.
4	Naturally spawned broodstock source from the nearest watershed; or a combination of naturally spawned and hatchery-reared broodstock from the local source.
3	Hatchery-reared broodstock source from the local or nearest watershed; or naturally spawned broodstock source from within the same ESU.
2	Hatchery-reared broodstock source from within the same ESU; or naturally spawned broodstock source from a different ESU.
1	Hatchery-reared broodstock source from a different ESU.

4.7.3.2 Numbers of Broodstock

Escapement and broodstock goals are based on probabilities associated with maintaining genetic variation, and limiting demographic risks, both to the hatchery-reared and naturally spawned components of the Russian River population(s).

Escapement goals are formulated to provide genetic redundancy. Numbers of the three listed species that are necessary to maintain a 95 percent probability of maintaining alleles occurring at a frequency of 1 percent or better for 15 years are presented in the Benefit/Risk Analysis (FishPro and ENTRIX 2002a). This document also contains estimate rates of allele retention for various numbers of broodstock utilized at a hatchery.

Determining and utilizing the minimum number of broodstock (N_b) necessary to maintain the genetic variability of the population can minimize risks to wild fish in a river. Table 4-46 organizes the potential range broodstock availability into five categories with a score of relative risk level.

Table 4-46 Numbers of Broodstock-Evaluation Criteria

Category Score	Evaluation Criteria Categories
5	Maintenance of N_b necessary to maintain genetic variation with a 95% probability, in both instream and hatchery components.
4	Instream escapement > 50% N_b and hatchery broodstock > 75% N_b.
3	Instream escapement < 50% N_b and hatchery broodstock > 50% N_b.
2	Instream escapement < 50% N_b and hatchery broodstock < 50% N_b.
1	Instream escapement < 50% N_b.

N_b is the effective number of breeders.

4.7.3.3 Broodstock Sampling and Mating Protocols

Table 4-47 organizes the potential range of sampling and mating procedures into five categories and provides a score of relative risk level for each mating-procedure category. Pedigree mating may be employed to maximize the transfer of genetic variation from one generation to the next.

Table 4-47 Broodstock Sampling and Mating-Evaluation Criteria

Category Score	Evaluation-Criteria Categories
5	Large naturally spawning component allowing random mating.
4	Large broodstock with pedigree mating.
3	Large broodstock with random mating; or medium broodstock with pedigree mating.
2	Medium broodstock with random mating; or small broodstock with pedigree mating.
1	Random mating precluded in naturally spawning component (due to small population size and/or isolation).

4.7.3.4 Rearing Techniques

A detailed description of the types of naturalized rearing environments that can be employed in hatcheries is presented in the Benefit/Risk Analysis (FishPro and ENTRIX 2002a).

Rearing techniques have the potential to affect the wild population primarily through artificial selection. Table 4-48 organizes the potential range of rearing techniques into five categories and provides a score of relative risk level for each of the rearing techniques.

Table 4-48 Rearing Techniques Evaluation Criteria

Category Score	Evaluation Criteria Categories
5	No hatchery captivity.
4	Low-density rearing with multiple NATURES features.
3	Low-density rearing.
2	High-density rearing with NATURES features.
1	High-density rearing.

To minimize the risk of disease transfer to the wild population, hatcheries should include adequate safeguards for fish health. NOAA Fisheries recommends the following fish health protocols:

- Adults contributing gametes should be regularly sampled for pathogens of common salmonid diseases.

- Incubation facilities should be sterilized before gametes are transported to them.

- Gametes brought into the facility should be isolated from all others and the resulting fertilized eggs disinfected. To avoid horizontal disease transfer, progeny should be isolated by full-sib family until cleared though pathological testing, and then monitored regularly during culture.

- Infected fish should be isolated and treated. However, some incipient level of disease is natural and also probably essential for immunological readiness for episodic outbreaks.

- If necessary, the hatchery water supply and effluent should be treated to minimize the transfer of pathogens to and from the natural population.

Adherence to NOAA Fisheries recommended guidelines for fish health management will minimize potential risk of disease transfer from the hatchery to wild populations to an undetectable level.

4.7.3.5 Release Strategies

Various strategies can be applied to the release of fish from hatcheries to improve the potential for successful returns and to minimize negative effects to naturally spawning populations. They include:

- Age of fish at release

- Acclimation and volitional release

- Release size

- Release locations

It is recommended that conservation hatcheries adopt practices aimed at reducing straying to no more than 5 percent. Conservation hatcheries should consequently rear fish for their entire juvenile freshwater lives in water from the intended return location.

It is recommended that any production programs in the Russian River release smolts within the observed size range of wild smolts. Releases of fish for supplementation purposes should occur only in locations where the habitat capacity exceeds the requirements of the local naturally spawning population.

Table 4-49 organizes the potential range of release strategies into five categories and provides a score of relative risk level. A score of 5 is given to no hatchery releases because no interactions between hatchery and naturally spawned fish would occur.

Table 4-49 Release Strategies Evaluation Criteria

Category Score	Evaluation Criteria Categories
5	No hatchery releases.
4	Volitional smolt releases into areas with known habitat carrying capacity.
3	Direct smolt releases into areas with known habitat carrying capacity.
2	Volitional smolt releases into areas with unknown habitat carrying capacity.
1	Direct smolt releases into areas with unknown habitat carrying capacity.

4.7.3.6 Duration in Hatchery Captivity

The duration of hatchery captivity has the potential to affect the wild population primarily through artificial selection. Table 4-50 organizes the anticipated range of hatchery captivity into five categories and provides each hatchery captivity program alternative with a score of relative risk level. The shorter the duration in hatchery captivity, the lower the risk of artificial selection.

Table 4-50 Duration in Hatchery Captivity Evaluation Criteria

Category Score	Evaluation Criteria Categories
5	No hatchery captivity.
4	Hatchery captivity through fry life stage.
3	Hatchery captivity through smolt life stage.
2	Hatchery captivity through adult life stage.
1	Hatchery captivity for repeated generations.

4.7.3.7 Harvest Management

Harvest management has the potential to affect the wild population primarily through unintended harvest bycatch of the nontarget population. Table 4-51 organizes the potential range of harvest management decisions into five categories and provides each program alternative with a score of relative risk level.

Table 4-51 Harvest Management Evaluation Criteria

Category Score	Evaluation Criteria Categories
5	No harvest allowed within basin.
4	Harvest allowed on one or more nonlisted, distinguishable/marked population, with comprehensive surveys to assess harvest, angler effort, and bycatch impacts to wild population.
3	Harvest allowed on one or more nonlisted, distinguishable/marked population, with moderate survey activity.
2	Harvest allowed on one or more nonlisted, distinguishable/marked population, with minimal survey activity.
1	No limits on harvest.

4.8 CRITERIA FOR ESTUARY MANAGEMENT

The primary action in the management of the Estuary is artificial breaching of a sandbar that forms naturally across the mouth of the river. Artificial breaching affects water quality in the Estuary, including salinity, temperature, DO, as well as instream cover and flow. These parameters affect salmonid rearing habitat and passage conditions.

Infrequent artificial breaching during the dry season would impair water quality. Optimal water quality conditions are expected to occur if the sandbar was to remain closed and the lagoon was allowed to convert to freshwater conditions. Alternatively, if the sandbar were to remain open, tidal flushing would help maintain water quality. Evaluation criteria for water quality were developed for both sandbar open and sandbar closed management.

4.8.1 SANDBAR CLOSED

Water quality criteria for sandbar closed (lagoon) management were also developed with the understanding that infrequent breaching is likely to result in degradation of water quality (Table 4-52).

Table 4-52 Sandbar Breaching Evaluation Criteria – Sandbar Closed

Category Score	Frequency of Artificial Breaching
5	No artificial breaching.
4	No artificial breaching during dry season until first winter storm; high to moderate inflow.
3	No artificial breaching before first winter storm; low or no inflow.
2	Infrequent artificial breaching; high to moderate inflow.
1	Infrequent artificial breaching; low or no inflow.

4.8.2 Sandbar Open

Evaluation criteria for water quality were developed assuming that by limiting the amount of time the sandbar remains closed during each closure event, effects to water quality can be minimized (Table 4-53).

Table 4-53 Sandbar Breaching Evaluation Criteria – Sandbar Open

Category Score	Frequency of Artificial Breaching (time sandbar remains closed)
5	0-5 days
4	6-10 days
3	11-14 days
2	15-21 days
1	> 22 days and < 40 days

Salmonid passage requirements include: 1) passage through the sandbar and Estuary, and 2) good water quality when passage occurs. Artificial breaching provides more passage opportunities than would occur under natural conditions. A key consideration is whether water quality is sufficient when additional passage occurs.

When the rainy season begins, the sandbar generally opens naturally. Rain and increased flow at this time would create good passage conditions for adults migrating up into the river. Water quality evaluation criteria under Estuary management are applied for adult salmonid passage from August to the first significant rains in September or October. These criteria are also applied for juvenile outmigration in the spring. Furthermore, artificial breaching affects the amount of time a closed sandbar could delay juvenile outmigration.

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Alevin is the life-history stage of a salmonid immediately after hatching and before the yolk-sac is absorbed. Alevins usually remain buried in the gravel in or near a series of redds until the yolk-sac is absorbed, after which they swim up and enter the water column.

Alleles are different forms of a gene at a single gene locus. A single nuclear gene contains two alleles. For example, a single gene may contain one allele that codes for blue eyes and another allele for brown eyes, or the gene may contain two alleles that code for blue eyes. Differences arise by mutation and are inherited by offspring.

Allele Frequency is the frequency of an allele in a given population. Differences in allele frequencies between populations are used to measure the amount of differentiation between populations.

Allozymes are alternative forms of an enzyme that have the same function, are produced by different alleles, and are often detected by protein electrophoresis.

Anadromous refers to a life-history in which growth and maturity occur in saltwater, but spawning and some juvenile rearing occur in freshwater.

Anadromy (adj. Anadromous) is the life-history pattern that features early juvenile development in fresh water, migration to seawater, and a return to fresh water for spawning.

Anthropogenic means caused by humans.

Approach velocity is the calculated velocity component perpendicular to the fish-screen face.

Artificial propagation of salmon refers to the practice of manually spawning adult fish and rearing the progeny in hatcheries, egg boxes, remote site incubators, or other facilities before release into the natural environment.

Biological Opinion is a document that includes: (1) the opinion of NOAA Fisheries as to whether or not a federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat; (2) a summary of the information on which the opinion is based; and (3) a detailed discussion of the effects of the action on listed species or designated critical habitat. [50 CFR §402.02, 50 CFR §402.14(h)]

Bottleneck is a sharp reduction of a breeding population’s size to a few individuals. It may have genetic consequences for the population.

Buildout refers to water supply and demand conditions at full implementation of the supply and transmission facilities authorized in the WSTSP.

Composite Population refers to the population that is comprised of both the hatchery-reared and naturally spawned population components.

Conservation is the use of artificial propagation to conserve genetic resources of a fish population at extremely low population abundance, and potential for extinction, using methods such as captive propagation and cryopreservation.

Critical Habitat for listed species consists of: (1) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the ESA, on which are found those physical or biological features (constituent elements) (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the ESA, upon a determination by the Secretary of the U.S. Dept. of the Interior that such areas are essential for the conservation of the species. [ESA §3 (5)(A)]

Dendogram is a graphic representation of genetic-relatedness between populations, generally in the form of a tree with branches.

Diploid refers to a genome when it contains two copies of each of its chromosomes. Microsatellite DNA is diploid, MtDNA is not (see haploid).

DNA (deoxyribonucleic acid) is a complex molecule that carries an organism's heritable information. The two types of DNA commonly used to examine genetic variation are mitochondrial DNA (mtDNA), a circular molecule that is maternally inherited, and nuclear DNA, which is organized into a set of chromosomes).

Domestication can occur when artificial selection in a hatchery environment produces fish with adaptations to the hatchery environment, but may result in loss of adaptations to the natural environment.

Effective Population Size is a mathematical construct that estimates the number of effectively breeding individuals in a population. It takes into account skewed sex ratios and variance in progeny number, as well as the actual number of breeders in a population.

Effective screen area is calculated by subtracting fish-screen area occluded by structural members from the total screen area.

Effects of the action are the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered, along with the environmental baseline and the predicted cumulative effects, to determine the overall effects to the species for purposes of preparing a biological opinion on the proposed action. [50 CFR §402.02] The environmental baseline covers past and present effects of all federal actions within the action area. This includes the effects of existing federal projects that have not yet come in for their Section 7 consultation.

Electrophoresis is the movement of charged particles in an electric field. This process is an analytical tool used to detect genetic variation revealed by charge differences on proteins or molecular weight in DNA. Data obtained by electrophoresis can provide insight into levels of genetic variability within populations and the extent of genetic differentiation between them.

Endangered species is a species in danger of extinction throughout all or a significant portion of its range.

Environmental baseline is the past and present impacts of all federal, state, or private actions and other human activities in an action area, the anticipated impacts of all proposed federal projects in an action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation process. [50 CFR §402.02]

Epistasis is the breakdown of coadapted gene complexes.

Escapement is the number of adult fish that "escape" fishing gear to migrate upstream to spawn.

Evolutionarily Significant Unit (ESU) is the NOAA Fisheries definition of a distinct population segment (the smallest biological unit that will be considered to be a species under the Endangered Species Act): A population will be/is considered to be an ESU if 1) it is substantially reproductively isolated from other nonspecific population units, and 2) it represents an important component in the evolutionary legacy of the species.

F_X refers to generations removed from the parental generation. F_1 refers to the progeny of a given parental cross, F_2 refers to the offspring of those progeny. For example, F_1 refers to children and F_2 refers to grandchildren.

Fitness is the capacity of an individual to leave fertile offspring to the next generation. It is the relative probability of survival and reproduction for a genotype.

Fluvial pertains to rivers and river action.

Formal consultation is a process between NOAA Fisheries and a federal agency or applicant that: (1) determines whether a proposed federal action is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat; (2) begins with a federal agency's written request and submittal of a complete initiation package; and (3) concludes with the issuance of a biological opinion and incidental take statement by NOAA Fisheries. If a proposed federal action may affect a listed species or designated critical habitat, formal consultation is required (except when NOAA Fisheries concur, in writing, that a proposed action "is not likely to adversely affect" listed species or designated critical habitat). [50 CFR §402.02. 50 CFR § 402.14]

Freshet is a sudden rise in the water level of a stream or flooding caused by heavy rains or snow melt.

Fry refers to the stage in the salmonid life history when the juvenile has absorbed its yolk sac and leaves the gravel of the redd to swim up into the water column.

Genes are the functional units of heredity, each being comprised of two alleles.

Genetic distance is a quantitative measure of genetic differences between a pair of samples.

Genetic drift is a stochastic process of genetic change through random changes in allele frequencies. These random changes can lead to loss or fixation of alleles in a population, and the magnitude of the effect is influenced by population size.

Genotype is the specific allelic composition of a cell, commonly for a gene or set of genes.

Haploid is a genome when it contains one (not two) copies of each of its chromosomes. MtDNA is haploid.

Haplotype is the specific allelic composition of a haploid cell.

Hardy-Weinburg equilibrium is a specific, stable frequency distribution of genotypes in a population that results from random mating without mutation, migration, natural selection, or random drift.

Harvest Bycatch is capture of non-target species in a harvest activity. For example, a harvest effort directed at hatchery steelhead may result in bycatch of Chinook or coho salmon, or even of wild steelhead.

Hatchery Fish is a fish that has spent some part of its life-cycle in an artificial environment and whose parents were spawned in an artificial environment.

Heterozygosity is a measure of allelic diversity at a locus (or averaged over several loci) whereby alternate alleles at a locus are different.

Heterozygous is the condition of having two different alleles at a given locus of a chromosome pair.

Infinite Allele Model of Kimura and Crow (1964) is a DNA mutation model that assumes each mutation creates a new allele with a low mutation rate. Unlike the stepwise mutation model, it assumes the mutation process erases any memory of previous alleles. Nei's D and Cavalli-Sforza and Edwards Chord Distance are genetic distances based on an infinite allele model.

Integrated Harvest Program is a project in which artificially propagated fish produced primarily for harvest are intended to spawn in the wild and are fully reproductively integrated with a particular natural population.

Integrated Recovery Program is an artificial propagation project primarily designed to aid in the recovery, conservation, or reintroduction of particular natural population(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). It is sometimes referred to as "supplementation."

Isolated Harvest Program is a project in which artificially propagated fish produced primarily for harvest are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Isolated Recovery Program is an artificial propagation project primarily designed to aid in the recovery, conservation, or reintroduction of particular natural population(s), but the fish produced are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Life-history stage refers to the developmental stage of the fish (e.g., egg, alevin, smolt, or adult).

Linkage is the association of genes on the same chromosome.

Listed Species is any species of fish, wildlife, or plant that has been determined to be endangered or threatened under section 4 of the ESA. [50 CFR §402.02]

Locus/loci is/are the site of a gene on a chromosome, often used interchangeably with gene.

Microsatellite DNA is a form of variable-number tandem repeats (VNTRs) composed of short tandem repeat segments of two-to-five base pairs per repeat unit (e.g., GTGTGT$(GT)_n$). Microsatellite DNA is frequently used in studies of parentage and for distinguishing closely related populations. They have some of the highest mutation rates of any molecular tools used to date, are generally considered to be selectively neutral, are thought to be inherited in a Mendelian fashion, and are easily amplified with PCR.

Mitigation is the use of artificial propagation to produce fish to replace or compensate for loss of fish or fish-production capacity resulting from the permanent blockage or alteration of habitat by human activities.

Monophyly is evolutionary development from a single ancestral form.

MtDNA (mitochondrial DNA) is a small, haploid molecule, maternally inherited, that is useful for phylogenetic reconstruction. Mitochondria are organelles in the cell that have their own DNA.

Natural Fish is a fish that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild.

Natural Population is a population that is sustained by natural spawning and rearing in the natural habitat.

NATURES (Natural Rearing Enhancement System) was developed to produce "wild-like" fish from hatcheries with increased post-release survival.

Nonanadromous describes fish that live in fresh water and do not migrate to saltwater.

Non-Target Population refers to populations that are not directly supported by an artificial propagation activity, but that are affected indirectly by artificial propagation activities intended to benefit another population.

Panmmictic Population is the result of random mating within a population.

Phenotype is the physical form taken by a genetic character, or group of characters, in an individual. It is the expression of genetic information (genotype).

Phylogeny is the evolution of genetically related organisms.

PIT tag (**passive integrated transponder** tag) is an injectable, internal, radiotype tag that allows unique identification of a marked fish passing within a few inches of a monitoring site.

Polymorphic means having many forms.

Population Component refers to the naturally spawned or hatchery-reared individuals inhabiting the same river system.

Recovery means improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA. [50 CFR §402.02]

Redd(s) is the nest (or series of nests) that female salmonids dig in the streambed in which to deposit their eggs.

Restriction Fragment Length Polymorphism (RFLP) analysis utilizes restriction enzymes to cut DNA strands that have nucleotide sequences specific to each enzyme. RFLP analysis can be used to detect both length variation and base substitution polymorphisms, and to detect DNA variation between individuals and between populations.

Salmonid means of, belonging to, or characteristic of the family *Salmonidae*, which includes the salmon, trout, char, and whitefish. Salmonids discussed in this document include two species of Pacific salmon (Chinook and coho), and one species of Pacific trout (steelhead/rainbow trout).

SAR stands for smolt-to-adult survival.

Screen mesh opening is the narrowest opening in the screen mesh.

Section 7 refers to the section of the ESA of 1973, as amended, outlining procedures for interagency cooperation to conserve federally listed species and designated critical habitats.

Smolt used as a verb means the physiological process that prepares a juvenile salmonid to survive the transition from fresh water to saltwater. Used as a noun, smolt refers to a juvenile anadromous fish that has smolted.

Species includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature. [ESA §3(16)]

Stock Transfer refers to the active collection of fish from one river for use in a supportive breeding program in another river. This includes the transfer of fish from one ESU to another.

Supportive Breeding refers to any artificial propagation activity aimed at increasing the abundance at any life-stage of a species.

Sweeping velocity is the flow-velocity component parallel to the fish-screen face with the pump turned off.

Target Population refers to the population intended to benefit from an artificial propagation activity.

Threatened species is a species not presently in danger of extinction but likely to become so in the foreseeable future.

Viable Population Threshold is an abundance level above which an independent Pacific salmonid population has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time-frame.

YOY (**young-of-the-year)** refers to fish in its first year of life.

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APPENDIX A

PROPOSED FLOW REGIME FOR THE RUSSIAN RIVER: IMPLEMENTATION PLAN AND PROPOSED PERMIT TERMS

SONOMA COUNTY WATER AGENCY
Proposed Flow Regime
Implementation Plan
June 13, 2003

Introduction

This plan describes in detail the operational criteria that the Sonoma County Water Agency (SCWA) intends to follow to: 1) comply with the minimum stream flow requirements expected to be prescribed by the State Water Resources Control Board (SWRCB) via amendment of the terms of the SCWA's appropriative water rights permits, and 2) achieve the additional anadromous fishery enhancement objectives of the SCWA's proposed flow regime.

Minimum Lake Mendocino Releases

The minimum stream flow requirements for the Russian River from Coyote Valley Dam to its Dry Creek confluence are listed in Table 1:

Table 1

Minimum Stream Flow Requirements for the Upper and Middle Russian River in CFS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	150	150	150	100	100	50	50	50	50	50	150/75[1]	150/75[1]
Dry	75	75	75	75	75	50	50	50	50	50	75	75
Critical	25	25	25	25	25	25	25	25	25	25	25	25
Dry Spring	150	150	150	100	100	50	50	50	50	50	75	75
East Fork	25	25	25	25	25	25	25	25	25	25	25	25

[1] 75 cfs when storage in Lake Mendocino is less that 30,000 AF

The flows labeled as "East Fork" are the minimum flows that apply to the East Fork Russian River between Coyote Dam and its confluence of the West Fork Russian River (the Forks). All the other minimum flows apply to the Russian River from the Forks to its confluence with Dry Creek. Normal minimum flow requirements apply when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year is greater than 130,000 acre-feet or 80 percent of the estimated water supply storage capacity of the reservoirs, whichever is less. Under these requirements, anytime between November 1 through December 31 storage in Lake Mendocino is less than 30,000 acre-feet, the required minimum flow rate is reduced from 150 cfs to 75 cfs. Dry Spring applies during normal water supply conditions and when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year is less than 130,000 acre-feet or 80 percent of the estimated water supply storage capacity of the reservoirs, whichever is less.

During those periods when the Corps of Engineers is not making releases for flood control purposes, SCWA determines releases from Lake Mendocino. Releases are made during these times, typically during the summer and fall, to maintain the minimum flows listed in Table 1. Additional releases are made from Lake Mendocino in accordance with the criteria described in the following sections to satisfy the water supply needs of SCWA and achieve the anadromous fishery objectives of the proposed flow regime.

Lake Mendocino Operating Criteria

Under the water rights permit terms prescribed by Decision 1610 of the SWRCB, SCWA's operating criteria contained no decision logic to base releases from Lake Mendocino on flow conditions in the lower Russian River. However, the proposed flow regime requires just this type of operation. Thus, under the proposed flow regime, the operator must consider not only flow conditions in the upper and middle Russian River (typically controlled at Healdsburg) in deciding the necessary release rate from Lake Mendocino, but also consider information to help the operator anticipate what the conditions in the lower Russian River will be and make releases from Lake Mendocino accordingly.

To do this, the operator considers the "target flows" for the mouth of Dry Creek, Santa Rosa hydrologic subunit monthly demands (which are largely SCWA's transmission system demands), the Santa Rosa subunit tributary inflows, the lower Russian River natural flows (as defined in the proposed water rights permit terms), and lower Russian River transition flows (as defined in the proposed flow regime). This information allows the operator to estimate the flow rates that need to be maintained at Healdsburg in order to attain a specific target flow range in Dry Creek while meeting the water supply demands and the minimum stream flow rates required at the Hacienda Bridge. The target flow rates for Dry Creek are listed in Table 2.

Table 2

Target Flow Rates for the Mouth of Dry Creek in CFS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	75	75	75	70	70	70	70	70	70	50	105	105
Dry	75	75	75	70	70	70	70	70	70	70	75	75
Critical	200	200	200	200	200	200	200	200	200	200	200	200
Dry Spring	75	75	75	70	70	70	70	70	70	70	105	105

The operator accomplishes this by first calculating the appropriate minimum flow for the lower Russian River by considering which of the following three conditions will likely prevail:

1. the sand bar is closed and the optimal estuary inflow is the minimum flow (90cfs$<Q_{Hacienda}<$150cfs and the month is from April through October);
2. the sandbar is closed and the natural flow is the minimum flow down to the absolute minimum flow rate of 35 cfs (35 cfs$<Q_{Hacienda}<$90 cfs) or;
3. the sandbar is open and the transition flow is the minimum flow ($Q_{Hacienda}>$150cfs).

At the U.S. Geological Survey stream flow gauging station Russian River near Guerneville, California the specified minimum flow rate refers to a five-day running average flow rate (with the instantaneous flow rate never less than 10 cfs below the specified minimum flow requirement).

The parenthetical comments above are assumptions made here for illustrative purposes. In this example (and in SCWA's computer modeling of the impacts of the proposed flow regime) it is assumed that the closure of the estuary will take place whenever the flow at Hacienda Bridge reaches 150 cfs. It is also assumed that the value of the optimal estuary inflow to balance the estuary elevation at 7.0 ft is 90 cfs. However, the operator will, in practice, consider the actual physical conditions in the estuary.

Once the lower Russian River minimum flow has been established, the operator will calculate the expected net SCWA demand at Wohler/Mirabel by subtracting the current tributary inflows from the current demands for the Santa Rosa subunit. Knowing the target flow for Dry Creek, the net demand at Wohler/Mirabel, the minimum flow at Hacienda Bridge, and the minimum flow at Healdsburg, the operator will calculate a target flow at Healdsburg (which may be greater or less than the minimum flow for Healdsburg). The operator then sets the release from Lake Mendocino high enough to either maintain the required minimum flows in the upper and middle Russian River (with an operating margin sufficient to allow for variables beyond the control of SCWA), or so that the anticipated demands between Coyote Valley Dam and Healdsburg will whittle the flow down to the target flow at Healdsburg, or the minimum flow, whichever is greater.

The operator does not know what the exact future demands and tributary inflows will be. Therefore the operator assumes the current demands and inflows will approximate the demands and inflows for three days into the future. Release rates from Lake Mendocino will not normally be changed more often that once every three days, to allow the upper and middle Russian River to approach a steady-state condition. This allows the operator to infer the current rate of consumptive uses between the Forks and Healdsburg from the differences in gauged flow rates.

The proposed water right permit terms allow an exception during Critical water supply conditions to increase flows in Dry Creek beyond the normal operational envelope. Thus, during that condition, the operator assumes a target flow from Dry Creek of 200 cfs, which communicates to the upper Russian River algorithm a reduced need for water from Coyote Dam, thereby conserving the water supply pool for upper and middle Russian River basin uses. Conversely, the October Dry Creek target flow under Normal water supply conditions is reduced from 70 to 50 cfs to so that the upper Russian River algorithm increases releases from Lake Mendocino to help purge the flood control pool and reduce a flow rate spike that would otherwise occur as the Corps of Engineers assumes flood operations control of releases.

There is a biological sensitivity to increasing release rates from Lake Mendocino. These increasing releases needed to meet increased demands could eventually begin to degrade the salmonid rearing habitat in the upper Russian River. Consequently, one of the goals of the proposed flow regime is to balance releases from the two reservoirs to maintain flow levels in both the upper Russian River and Dry Creek that create good rearing habitat for salmonids. To accomplish this, there is a flow rate envelope for the upper and middle Russian River. The envelope is defined by the upper and lower range of flow rates that provide a quality of flow-related habitat consistent with the needs of rearing juvenile salmonids. The upper flow rates are not appropriate as permit terms, but rather are operational goals that the SCWA will strive to meet as future demands increase. The lower range of the flow regulation envelope for the upper and middle Russian River are the minimum flows required by the proposed water rights permit terms listed in Table 1. The upper boundary of the flow regulation envelope at Healdsburg is listed in Table 3.

The operational goal of remaining within the flow envelope will be achieved by limiting the amount of Santa Rosa subunit demand that will be met through releases from Lake Mendocino. If necessary, the balance of the demand is then met by increasing the flow rate at the mouth of Dry Creek. In addition to protecting both the upper Russian River salmonid habitat, this also increases the reliability of the water supply in Lake Mendocino.

Table 3

Healdsburg Upper Flow Envelope (in cfs)

Jun	Jul	Aug	Sep	Oct	Nov
200	180	160	140	140	170

Minimum Lake Sonoma Releases

The proposed flow regime specifies minimum flow rates for Dry Creek and for the lower Russian River. The Dry Creek minimum flow rates meet the migration and rearing habitat needs of juvenile salmonids in Dry Creek. The Dry Creek minimum flows are listed in Table 4.

Table 4

Minimum Stream Flow Requirements for Dry Creek in CFS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	90	90	90	50	50	25	25	25	25	25	90	90
Dry	75	75	75	50	50	25	25	25	25	25	75	75
Critical	75	75	75	50	50	25	25	25	25	25	75	75

The required minimum flow rate for the lower Russian River generally is the natural flow at Hacienda Bridge. However, there is a specified absolute minimum flow rate of 35 cfs. All of the specified minimum flow rates at Hacienda Bridge refer to a five-day running average flow rate (with the instantaneous flow rate never less than 10 cfs below the specified minimum flow requirement). The natural flow of the Russian River at Hacienda Bridge (U.S. Geological Survey gauging station Russian River near Guerneville) is defined as 11.77 times the four-day running average of the gauged flow of Austin Creek at the U.S. Geological Survey gauging station Austin Creek near Cazadero, California. During periods in which that gauge is malfunctioning or otherwise not available, the natural flow is defined as 24.89 times the four-day running average of the gauged flow of Maacama Creek at the U.S. Geological Survey gauging station Maacama Creek near Kellogg, California.

Releases from reservoir storage are not required to be made to maintain the natural flow rate once it rises above a specified "transition flow rate." The transition flow rates for the lower Russian River are listed in Table 5.

Table 5

Lower Russian River Transition Flow Rates in CFS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	125	125	125	150	150	125	125	125	125	125	125	125
Dry	125	125	125	150	150	125	125	125	125	125	125	125
Critical	35	35	35	35	35	35	35	35	35	125	125	125
Dry Spring	125	125	125	150	150	125	125	125	125	125	125	125

An exception to the lower Russian River minimum flow rate requirements applies in order to prevent flooding in the estuary without the need for artificial breaching. When the sand bar at the mouth of the river closes, the required minimum flow at Hacienda Bridge changes from either the natural flow rate or the transition flow rate, whichever is then governing, to a flow rate designated as the Optimal Estuary Inflow (OEI). The minimum required flow then remains at the OEI until the natural flow rate drops below the OEI. At that time, the natural flow rate once again becomes the required minimum flow rate until the natural flow rate declines to the floor value of 35 cfs, where the minimum flow rate remains until the natural flow rate increases back to the point it exceeds 35 cfs. The OEI is defined as the flow at Hacienda Bridge that will result in an estuary water surface elevation stabilized at 7.0 feet. The OEI has been estimated to be approximately 90 cfs. However, the OEI is not constant and changes throughout the year in response to ocean conditions.

Lake Sonoma Operating Criteria

Compared to the operation of Lake Mendocino, the operation of Lake Sonoma is relatively straightforward. The operator makes releases from Lake Sonoma at the rates necessary either to meet the required minimum flow rates listed in Table 4 (with an operating margin sufficient to allow for variables beyond the control of the SCWA) or the governing minimum flow rate at Hacienda Bridge, whichever requires the larger release rate. During those periods when either the transition flow rates listed in Table 5, or the absolute minimum flow rate of 35 cfs, governs releases, additional water will be releases at a rate sufficient to provide an operating margin sufficient to allow for variables beyond the control of the SCWA. Unlike at Lake Mendocino, where a change in the rate of release should only be made every three or four days, Lake Sonoma release rate changes can be made more frequently. Since the travel time to the SCWA's water transmission system intakes for water released from Lake Sonoma is much shorter that that released from Lake Mendocino, daily variations in the lower Russian River flows will be regulated with releases from Lake Sonoma.

Additional Measures

As was the case for the upper and middle Russian River, there is also a flow rate envelope for Dry Creek. The upper range of the flow envelope for Dry Creek is 90 cfs during Normal and Dry water supply conditions. There is no upper range during Critical water supply conditions. The lower range of the flow regulation envelope for Dry Creek is the minimum flows required by the proposed water rights permit terms listed in Table 4 (with an operating margin sufficient to allow for variables beyond the control of the SCWA).

Since releases must be made from Lake Sonoma at the rates necessary to meet the required lower Russian River minimum flow rates, the only means available to keep Dry Creek flow rates from exceeding the upper range of the flow envelope are physical facilities to limit the need for releases from Lake Sonoma to Dry Creek. These measures could consist of a number of different types of facilities. These include, but are not limited to, aquifer storage and recovery facilities to partially satisfy peak summer water transmission system demands, or a pipeline paralleling Dry Creek to divert water from Lake Sonoma and convey it to the Russian River downstream from the mouth of Dry Creek. While such measures are unnecessary under current water demand conditions, they likely will be necessary in the future.

A series of model runs were performed to define the additional measures that will be necessary in the future to maintain the desired flow levels. Based upon the results of these model studies, additional measures are planned to be constructed that will provide a continuous water supply flow rate during the months of June through September starting at 3 million gallons per day (MGD) when the SCWA water transmission system peak month demand reaches 83 MGD. Further measures are planned to be constructed in stages as shown in Table 6. The model runs demonstrated that the timely construction of these measures will assure that the desired flow levels in Dry Creek and the upper and middle Russian Rivers will be able to be maintained under all projected future demand conditions.

Table 6

Implementation Schedule for Additional Measures

SCWA Demand Level (MGD)	Additional Measures (MGD)
73	0
83	0
93	5
104	22
115	37

Proposed Flow Regime
Proposed Water Rights Permit Terms
June 13, 2003

The following revisions to appropriative water rights permits held by the Agency are proposed to implement the Enhanced Natural Flow Proposal:

Permit 16596

Term 13 is to be amended to read as follows:

For the protection of fish and wildlife in Dry Creek and the Russian River, unless the elevation of the water level in Lake Sonoma is below 292.0 feet, with reference to the National Geodetic Vertical Datum of 1929, or unless prohibited by the U.S. Army Corps of Engineers acting under its reserved rights specified in the October 1, 1982 contract between permittee and the United States (or any successor agreement), permittee shall pass through or release from storage at Lake Sonoma sufficient water to maintain:

(A) The following minimum flow rates in Dry Creek between Warm Springs Dam and its confluence with the Russian River:

(1) During normal water supply conditions:

90 cfs from January 1 through March 31
50 cfs from April 1 through May 31
25 cfs from June 1 through October 31
90 cfs from November 1 through December 30

(2) During dry or critical water supply conditions:

75 cfs from January 1 through March 31
50 cfs from April 1 through May 31
25 cfs from June 1 through October 31
75 cfs from November 1 through December 31

(B) At the United States Geological Survey stream flow gauging station Russian River near Guerneville, California a five-day running average flow rate (with the instantaneous flow rate never less than 10 cfs below the specified minimum flow requirement) of 35 cfs, to the extent such flow cannot be met by releases from storage at Lake Mendocino under Permit 12947A issued on Application 12919A:

For the purposes of the requirements of this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1

20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases from Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury.

(6) Estimated water supply storage space is the reservoir volume below elevation 1,828.3 feet in Lake Pillsbury and below elevation 749.0 feet in Lake Mendocino. Both elevations refer to the National Geodetic Vertical Datum of 1929. The volume shall be determined using the most recent reservoir volume surveys made by the U.S. Geological Survey, U.S. Army Corps of Engineers, or other responsible agency.

Permit 12947A

Term 18 is amended to read as follows:

For the protection of fish and wildlife, unless prohibited by the U.S. Army Corps of Engineers acting within its reserved rights under the water storage space agreement between permittee and the United States (or any successor agreement), permittee shall pass through or release from storage at Lake Mendocino sufficient water to maintain the following minimum flow rates:

(A) A flow rate in the East Fork Russian River from Coyote Valley Dam to its confluence with the Russian River of 25 cfs.

(B) In the Russian River between its confluence with the East Fork Russian River and its confluence with Dry Creek, the following flow rates:

(1) During normal water supply conditions and when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year exceeds 130,000 acre-feet or 80 percent of the estimated water supply storage capacity of the reservoirs, whichever is less:

100 cfs from April 1 through May 31
50 cfs from June 1 through October 31
150 cfs from November 1 through March 31

provided, however, if anytime between November 1 through December 31, storage in Lake Mendocino is less than 30,000 acre-feet, the required minimum flow rate shall be 75 cfs.

(2) During normal water supply conditions and when the combined water in storage, including dead storage, in Lake Pillsbury and Lake Mendocino on May 31 of any year is less than 130,000 acre-feet or 80 percent of the estimated water supply storage capacity of the reservoirs, whichever is less:

100 cfs from April 1 through May 31
50 cfs from June 1 through October 31

75 cfs from November 1 through December 31
150 cfs from January 1 through March 31

(3) During dry water supply conditions:

50 cfs from June 1 through October 31
75 cfs from November 1 through May 31

(4) During critical water supply conditions:

25 cfs during all months.

(C) At the United States Geological Survey stream flow gauging station Russian River near Guerneville, California, a five-day running average flow rate (with the instantaneous flow rate never less than 10 cfs below the specified minimum flow requirement) that is the lesser of 1) the natural flow rate or 35 cfs, whichever is greater, and 2) the following flow rates:

(1) During normal and dry water supply conditions

125 cfs from October 1 through March 31
150 cfs from April 1 through May 31
125 cfs from June 1 through September 30

(2) During critical water supply conditions

125 cfs from October 1 through December 31
35 cfs from January 1 through September 30

provided, however, during those periods when the Russian River estuary is closed by a sand bar, permittee may reduce the flows at the United States Geological Survey stream flow gauging station Russian River near Guerneville, California below the minimum specified above, if, and to the extent that, such reductions are reasonably necessary so that the water surface elevation in the estuary will not exceed 7.0 feet, with reference to the National Geodetic Vertical Datum of 1929.

For the purposes of the requirements of this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases from Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury.

(6) Estimated water supply storage space is the reservoir volume below elevation 1,828.3 feet in Lake Pillsbury and below elevation 749.0 feet in Lake Mendocino. Both elevations refer to the National Geodetic Vertical Datum of 1929. The volume shall be determined using the most recent reservoir volume surveys made by the U.S. Geological Survey, U.S. Army Corps of Engineers, or other responsible agency.

(7) The natural flow of the Russian River at the U.S. Geological Survey gauging station Russian River near Guerneville, California is defined as 11.77 times the four-day running average of the gauged flow of Austin Creek at the U.S. Geological Survey gauging station Austin Creek near Cazadero, California. During periods in which this gauge is malfunctioning or otherwise not available, the natural flow is defined as 24.89 times the four-day running average of the gauged flow of Maacama Creek at the U.S. Geological Survey gauging station Maacama Creek near Kellogg, California. These flow ratios may be modified by permittee, upon written application by permittee, supported by at least five years of new stream flow records at the Austin Creek or Maacama Creek gauging stations, so that the above formulas will more accurately estimate the natural flow of the Russian River. The “natural flow of the Russian River” is that flow that would occur in the Russian River if there were no imports of water into the Russian River basin, no releases of stored water and no diversions of water from the Russian River or any of its tributaries.

Permit 12949

Term 15 is amended to read as follows:

For the protection of fish and wildlife, and the maintenance of recreation in the Russian River, permittee shall allow sufficient water to bypass the points of diversion to maintain the following minimum flows at the Russian River at the U.S. Geological Survey gauging station Russian River near Guerneville, California:

A five-day running average flow rate (with the instantaneous flow rate never less than 10 cfs below the specified minimum flow requirement) that is the lesser of 1) the natural flow rate or 35 cfs, whichever is greater, and 2) the following flow rates:

(1) During normal and dry water supply conditions

125 cfs from October 1 through March 31
150 cfs from April 1 through May 31
125 cfs from June 1 through September 30

(2) During critical water supply conditions

125 cfs from October 1 through December 31
35 cfs from January 1 through September 30

provided, however, during those periods when the Russian River estuary is closed by a sand bar, permittee may reduce the flows at the U.S. Geological Survey stream flow gauging station Russian River near Guerneville, California below the minimum specified above, if, and to the extent that, such reductions are reasonably necessary so that the water surface elevation in the estuary will not exceed 7.0 feet, with reference to the National Geodetic Vertical Datum of 1929.

For the purposes of the requirements of this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases from Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury.

(6) The natural flow of the Russian River at the U.S. Geological Survey gauging station Russian River near Guerneville, California is defined as 11.77 times the four-day running average of the gauged flow of Austin Creek at the U.S. Geological Survey gauging station Austin Creek near Cazadero, California. During periods in which this gauge is malfunctioning or otherwise not available, the natural flow is defined as 24.89 times the four-day running average of the gauged flow of Maacama Creek at the United States Geological Survey gauging station Maacama Creek near Kellogg, California. These flow ratios may be modified by permittee, upon written application by permittee, supported by at least five years of new stream flow records at the Austin Creek or Maacama Creek gauging stations, so that the above formulas will more accurately estimate the natural flow of the Russian River. The "natural flow of the Russian River" is that flow that would occur in the Russian River if there were no imports of water into the Russian River basin, no releases of stored water and no diversions of water from the Russian River or any of its tributaries.

Permit 12950

Term 15 is amended to read as follows:

For the protection of fish and wildlife, and the maintenance of recreation in the Russian River, permittee shall allow sufficient water to bypass the points of diversion to maintain the following minimum flows at the Russian River at the U.S. Geological Survey gauging station Russian River near Guerneville, California:

A five-day running average flow rate (with the instantaneous flow rate never less than 10 cfs below the specified minimum flow requirement) that is the lesser of 1) the natural flow rate or 35 cfs, whichever is greater, and 2) the following flow rates:

(1) During normal and dry water supply conditions

125 cfs from October 1 through March 31
150 cfs from April 1 through May 31
125 cfs from June 1 through September 30

(2) During critical water supply conditions

125 cfs from October 1 through December 31
35 cfs from January 1 through September 30

provided, however, during those periods when the Russian River estuary is closed by a sand bar, permittee may reduce the flows at the U.S. Geological Survey stream flow gauging station Russian River near Guerneville, California below the minimum specified above, if, and to the extent that, such reductions are reasonably necessary so that the water surface elevation in the estuary will not exceed 7.0 feet, with reference to the National Geodetic Vertical Datum of 1929.

For the purposes of the requirements of this term, the following definitions shall apply:

(1) Dry water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

8,000 acre-feet as of January 1
39,200 acre-feet as of February 1
65,700 acre-feet as of March 1
114,500 acre-feet as of April 1
145,600 acre-feet as of May 1
160,000 acre-feet as of June 1

(2) Critical water supply conditions exist when cumulative inflow to Lake Pillsbury beginning on October 1 of each year is less than:

4,000 acre-feet as of January 1
20,000 acre-feet as of February 1
45,000 acre-feet as of March 1
50,000 acre-feet as of April 1
70,000 acre-feet as of May 1
75,000 acre-feet as of June 1

(3) Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

(4) The water supply condition designation for the months of July through December shall be the same as the designation for the previous June. Water supply conditions for January through June shall be redetermined monthly.

(5) Cumulative inflow to Lake Pillsbury is the calculated algebraic sum of releases from Lake Pillsbury, increases in storage in Lake Pillsbury, and evaporation from Lake Pillsbury.

(6) The natural flow of the Russian River at the U.S. Geological Survey gauging station Russian River near Guerneville, California is defined as 11.77 times the four-day running average of the gauged flow of Austin Creek at the U.S. Geological Survey gauging station Austin Creek near Cazadero, California. During periods in which this gauge is malfunctioning or otherwise not available, the natural flow is defined as 24.89 times the four-day running average of the gauged flow of Maacama Creek at the United States Geological Survey gauging station Maacama Creek near Kellogg, California. These flow ratios may be modified by permittee, upon written application by permittee, supported by at least five years of new stream flow records at the Austin Creek or Maacama Creek gauging stations, so that the above formulas will more accurately estimate the natural flow of the Russian River. The "natural flow of the Russian River" is that flow that would occur in the Russian River if there were no imports of water into the Russian River basin, no releases of stored water and no diversions of water from the Russian River or any of its tributaries.